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SURFACE OPTICAL PROPERTY MEASUREMENTS
ON BARK AND LEAF SAMPLES

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This paper presents reflectance data for leaf and bark samples taken from a big-leaf aspen tree located near Orono, ME. Total hemispherical directional reflectance measurements were made for several angles of incidence between 20 and 80° and over the 0.3 to 25.0 μm spectral region. Since the leaves are translucent, transmittance measurements were also made. Bidirectional reflectances were measured for incident angles of 20, 40 and 60° at wavelengths of 1.3, 4.6 and 10.0 μm. In addition, some reflectance data from a concrete runway and adjacent grasses are presented.

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PREFACE

Enclosed as an appendix is Surface Optics Corporation's (SOC) Final Report to Spectral Sciences, Inc. (SSI) entitled, "Surface Optical Property Measurements on Bark and Leaf Samples". This report has been reviewed by SSI and found to be acceptable under Contract No. F19628-89-C-0128.

SOC-R628-002-1290

SURFACE OPTICAL PROPERTY MEASUREMENTS ON BARK AND LEAF SAMPLES

FINAL REPORT AND APPENDICES A THROUGH Y

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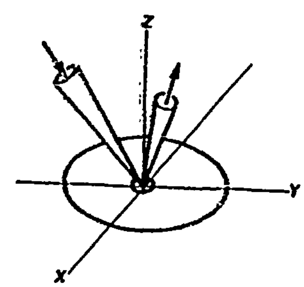

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1.0 INTRODUCTION

This work was performed for Spectral Sciences, Inc. (SSI) under Contract Number F19628-89-C-0128.

Infrared backgrounds play an important role in determining target contrast signatures and hence the ability of an IR sensor to detect and track a target. Target simulation models used in systems analysis must also calculate the background radiances in order to predict the brightness of a target relative to various background scene elements. To meet this need, the Balanced Technology Initiative (BTI) for Smart Weapons Operability Enhancement (SWOE) has established the modeling of the infrared (IR) radiation from complex natural backgrounds as a program requirement. As a starting point, vegetative backgrounds offer particular modeling challenges due to their extensive variability in types, distributions, and states of vegetation. One vegetation type of concern is a single or small group of trees, such as might be found in a clearing or around buildings.

This report presents the results from laboratory measurements of the reflectances and transmittances of leaves and bark from a single big-leaf aspen tree located in Maine. The tree was instrumented with thermocouples, and the diurnal structure of its temperature was measured in September, 1990.[1] The leaves and bark samples were taken from the tree in September, shipped overnight to Surface Optics Corporation (SOC) and measured over a two and one-half week period. The total hemispherical reflectance was measured in the 0.3 to 25.0 μm spectral region, and the bidirectional reflectance was measured at three IR wavelengths, 1.3, 4.6 and 10.0 μm. The leaves were found to be translucent, so transmittance measurements were also made. SOC had made previous measurements from samples of other background materials taken from Wright-Patterson AFB, concrete runways and adjacent grasses.[2] These measurements are also included in Appendix Y.

Section 2.0 describes the measurements which were made on the leaf and bark samples. A review of the standard nomenclature for directional and bidirectional reflectance parameters is given in Section 3.0. Descriptions of the laboratory equipment used for the measurements are given in the next two sections, data reduction is described in Section 6.0, and a detailed analysis of the samples and measurement procedures is given in Section 7.0. Finally, all the data with supporting graphs are presented in the Appendices. Since the samples, especially the leaves, showed significant degradation before and during the measurement process, an attempt has been made to fully characterize the timing and repeatability of the measurement. Thus the reader is

---

[1] J.R. Hummel, J.R. Jones, M.G. Cheifetz, D.R. Longtin, and N.L. Paul, "Thermal Modelling of Natural Backgrounds for BTI/SWOE Program", presented at 1991 IRIS TBD meeting, ERIM, Ann Arbor, MI.

[2] J.T. Neu et. al., "Surface Optical Property Measurements on Samples of Target and Background Materials from WPAFB Area B", prepared under Contract No. F33615-86-C-1102, SOC Report Number SOC-0086(R)-024 (September 1986).

cautioned to allow for error bars when using these data; as an initial estimate, the authors suggest a maximum uncertainty of 12% for the angular data on the top side of the leaf in the spectral band of 0.5 to 2.0 μm. The uncertainty in the angular data for the bottom side of the leaf is estimated to be ~ 3% reflectance over the same spectral band as the top side. All other measurements fall within 2%.

2.0 SAMPLE DESCRIPTIONS AND MEASUREMENTS REQUIRED

The vegetative samples used for these measurements included two bark samples taken from heights of 51 and 55" on the tree and five small branches with multiple leaves. The total number of leaves was approximately twerty. The branches were shipped with bud vases so that they had a constant supply of water up to the time of measurement. Upon receipt at SOC, they were kept refrigerated until measured. A second set of leaves from a different tree were received in October; these leaves were much dryer and on the verge of turning color. They were taken from an aspen located in Lexington, MA, and handled in a similar manner. Because of the heat generated from the internal light sources in the instruments, the leaves changed significantly (drying out) during the time of measurement. In order to provide an indication of the effects of drying, some of the leaf measurements were repeated on samples that had been left out to dry for several days.

Tables 1 provide an overview of all measurements made with the bark and leaf samples. Table 1 (a) gives the directional reflectance measurements made at 20° angle of incidence on the leaves and bark received in September, 1990, and their ERAS identification numbers. Table 1 (b) lists the full set of measurements made on the September samples; these include directional reflectance at different angles of incidence, the derived thermal emittances and the bidirectional reflectances at three angles of incidence. Table 1 (c) tabulates measurement information for the second set of leaf samples.

Table 1 (a)

Measurement Matrix
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ERAS FORMAT BASIC NUMBER	SSI MATERIAL DESCRIPTION	DIRECTIONAL REFLECTANCE $\phi_i = 0, 90°$, $\theta_i = 20°$	
		λ = 0.3 to 2.0 μm	λ = 2.0 to 25.0 μm
FS4833[1]	Bark Sample #1: 2:00 PM West Side, 55" up	X	X[2]
FS4834[1]	Bark Sample #2: 2:16 PM North East Side, 51" up	X	X[2]
FS4835	Leaf Sample: Top Side	X	X
FS4836	Leaf Sample: Bottom Side	X	X

1 For bark samples FS4833 and FS4834, ϕ_i = 0° implies that the plane of incidence of the beam is aligned with the vertical direction of the bark as if it were on the tree. The ϕ_i = 90° orientation implies that the plane of incidence is aligned with the horizontal direction of the bark. Raw material for the bark was cut such that the longest dimension was in the vertical direction of the tree.

2 Measure bark samples up to 10.0 μm.

Table 1 (b)

Measurement Matrix
Spectral Sciences, Inc.

ERAS FORMAT BASIC NUMBER	SSI MATERIAL DESCRIPTION	DIRECTIONAL REFLECTANCE $\phi_i = 0°$ θ_i = 20,30,40,50,60,70,75,80°		HEMISPHERICAL THERMAL EMITTANCE and ANGULAR SOLAR ABSORPTANCE	IN-PLANE CROSS-PLANE AND RING BIDIRECTIONAL REFLECTANCE $\phi_i = 0°$ θ_i = 20,40,60°
		λ = 0.3 to 1.6 µm	λ = 1.6 to 25.0 µm		λ = 1.307, 4.601, 10.0 µm
FS4833	Bark Sample #1: 2:00 PM West Side, 55" up	X	X	X	X
FS4834	Bark Sample #2: 2:16 PM North East Side, 51" up	X	X	X	X
FS4835	Leaf Sample: Top Side	X	X	X	X
FS3836	Leaf Sample: Bottom Side	X	X	X	X

Note For measurements made at 1.6 µm and above use the following wavelengths. 1.6, 1.7, 1.8, 1.9, 2.0. 2.2, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0, 5.5, 6.0, 6.5, 7.0, 7.5, 8.0, 8.5, 9.0, 9.5, 10.0, 10.5, 11.0, 12.0, 13.0, 14.0, 15.0, 16.0, 17.0, 18.0, 19.0, 20.0, 21.0, 22.0, 23.0, 24.0, 25.0 µm.

Table 1 (c)

Measurement Matrix
Spectral Sciences, Inc.

ERAS FORMAT BASIC NUMBER	SSI MATERIAL DESCRIPTION	DIRECTIONAL REFLECTANCE[1] $\phi_i = 0°, \theta_i = 20°$		SCATTERED TRANSMITTANCE $\phi_i = 0°, \theta_i = 20°$	
		$\lambda = 0.3$ to $2.0\ \mu m$	$\lambda = 2.0$ to $26.0\ \mu m$	$\lambda = 0.3$ to $2.0\ \mu m$	$\lambda = 2.0$ to $26.0\ \mu m$
FS4866	Green Aspen Leaf, Bottom of Leaf A	X	X		
FS4867	Green Aspen Leaf, Top of Leaf A	X	X		
FS4868	Green Aspen Leaf, Bottom of Leaf B	X	X		
FS4869	Green Aspen Leaf, Top of Leaf C	X	X		
FS4870	Green Aspen Leaf, Bottom of Leaf C	X	X		
FS4871	Green Aspen Leaf, Top of Leaf B	X	X		
FS4872	Green Aspen Leaf, Top of Leaf D	X	X		
FS4873	Green Aspen Leaf, Bottom of Leaf D	X	X		
FS4874	Green Aspen Leaf, Top of Leaf E	X	X		
FS4875	Green Aspen Leaf, Bottom of Leaf E	X	X		
FS4876	Green Aspen Leaf, Top of Leaf F	X	X		
FS4877	Green Aspen Leaf, Bottom of Leaf F	X	X		
FS4878	Green Aspen Leaf, Top of Leaf G	X	X		
FS4879	Green Aspen Leaf, Bottom of Leaf G	X	X		
FS4880	Green Aspen Leaf, Top of Leaf H	X	X		
FS4881	Green Aspen Leaf, Bottom of Leaf H	X	X		
FS4882	Green Aspen Leaf, Transmittance #1			X	X
FS4883	Green Aspen Leaf, Transmittance #2			X	X
FS4884	Green Aspen Leaf, Transmittance #3			X	X
FS4885	Green Aspen Leaf, Transmittance #4			X	X

1 Measure directional reflectance on the day the leaves are received (19 October 1990) and then again after being left out for three (3) days (22 October 1990) at room temperature.

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3.0 DEFINITIONS AND NOMENCLATURE

3.1 Symbols and Units

Table 2 contains a listing of the symbols and units of quantities used in this investigation.

3.2 Coordinate System and Sign Convention

The quantities of reflectometry are conveniently referenced to a spherical polar coordinate system of unit radius (θ,ϕ) as shown in Figure 1.

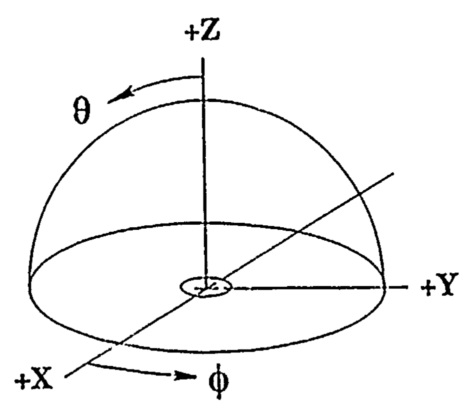

Figure 1. Coordinate System for Reflectometry Measurements.

The sample center coincides with the origin of a right-handed Cartesian-coordinate system (x,y,z). The polar angle θ is measured downward from the positive z-axis, the azimuth angle ϕ counterclockwise from the positive x-axis. A fiducial mark placed at the edge of the sample serves to orient it relative to the coordinate axes. If the sample is smooth or randomly rough, the location of the mark is arbitrary and serves no other purpose than to provide the operator with a convenient reference during a set of measurements or for correlation of measurements made on more than one instrument. If the sample surface exhibits preferred orientation, such as striae resulting from machining, weaving, etc., it is SOC practice to align the fiducial mark in the direction of the striae as shown in Figure 2.

Table 2
Symbols and Units

		SYMBOL	UNITS
BDR	=	Bidirectional Reflectance	$steradians^{-1}$
DR	=	Directional Reflectance	dimensionless
J_λ	=	Johnson's Solar Irradiance Function	watts $meter^{-2}$.$micrometers^{-1}$
N_i	=	Source Radiance	watts $meter^{-2}$.$steradians^{-1}$
N_r	=	Reflected Radiance	watts $meter^{-2}$.$steradians^{-1}$
α	=	Solar Absorptivity	dimensionless
β	=	Bandpass	micrometers
ε_d	=	Spectral Directional Emittance	dimensionless
θ_i	=	Incident Polar Angle	degrees
θ_r	=	Reflected Polar Angle	degrees
λ	=	Wavelength	micrometers
λ_l	=	Lower Value of Wavelength	micrometers
λ_u	=	Upper Value of Wavelength	micrometers
Ψ	=	Diffraction Angle	degrees
$\parallel$	=	Parallel Polarized Light	
$\perp$	=	Perpendicular Polarized Light	
ρ_d	=	Directional Reflectance of an Unpolarized Incident Beam	dimensionless
ρ_d^u	=	Directional Reflectance Uncorrected for Instrumentation Polarization	dimensionless
ρ'	=	Bidirectional Reflectance	$steradians^{-1}$
ϕ_i	=	Incident Azimuth Angle	degrees
ϕ_r	=	Reflected Azimuth Angle	degrees
T	=	Temperature	degrees
$d\omega_i$	=	Source Solid Angle	steradians
$d\omega_r$	=	Reflected Solid Angle	steradians
T_c	=	Collimated Transmittance	dimensionless
T_s	=	Scattered Transmittance	dimensionless
h	=	Planck's Constant	joule.sec
c	=	Speed of Light	m.sec^{-1}
k	=	Boltzman's Constant	joule.$kelvin^{-1}$

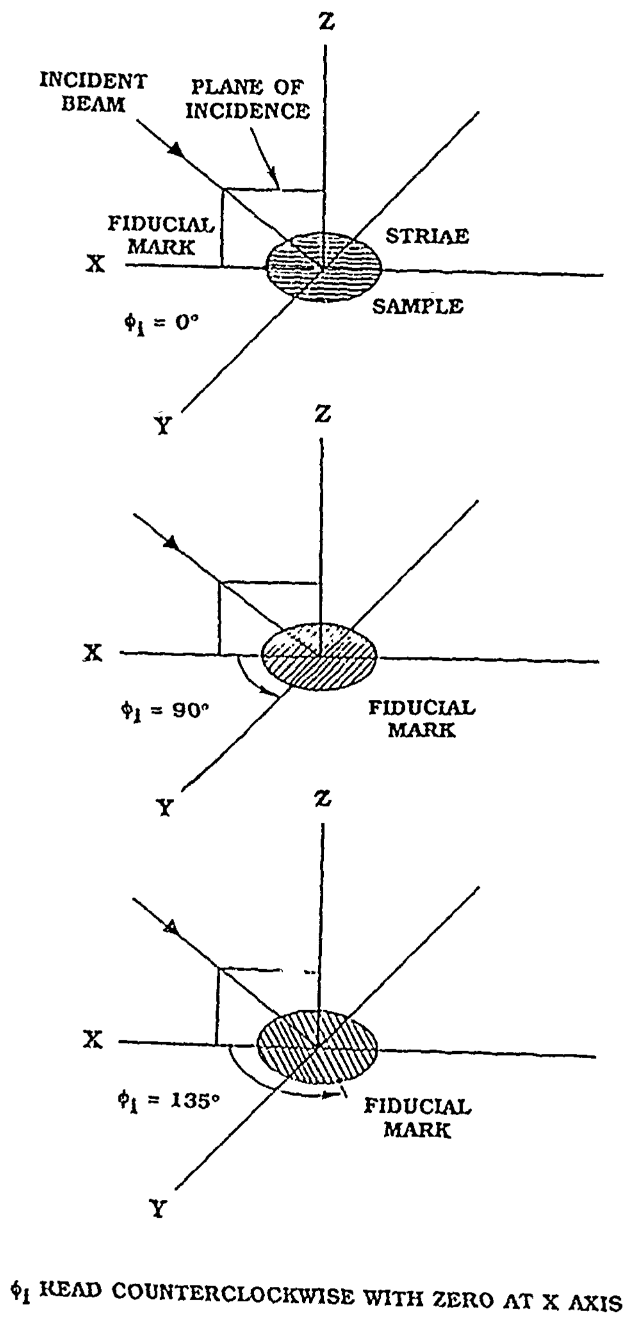

Figure 2. Definition of Striae Orientation.

3.3 Polarization Convention

When reflectance measurements are made with polarized light, the directions of polarization are defined relative to the plane formed by the incident beam and the normal to the sample face. For an unpolarized incident beam, the reflected light (electric field vector) vibrating in the plane of incidence is called parallel polarized. The reflected light vibrating normal to the plane of incidence is said to be perpendicularly polarized (Figure 3).

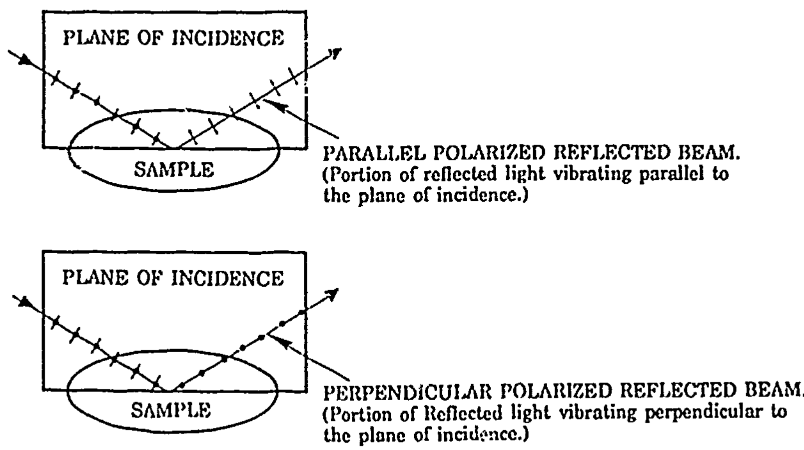

Figure 3. Convention Describing the Polarization of Reflected Light.

4.0 REFLECTANCE PROPERTIES

4.1 Directional Reflectance

The directional reflectance (DR) of a surface is defined as the ratio of the total energy reflected into the subtending hemisphere to the energy incident on the surface from the direction θ_i,ϕ_i (Figure 4).

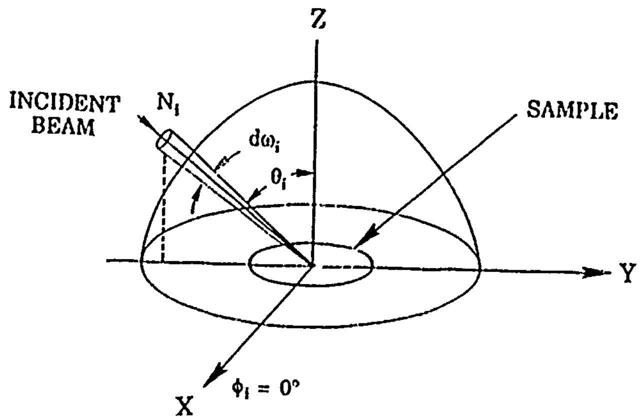

Figure 4. Diagram Illustrating Concept of Directional Reflectance.

Following the notation of Nicodemus[3] the directional reflectance may be expressed in terms of primary quantities as

$$\rho_d(\theta_i,\phi_i) = \frac{\int_0^{2\pi} \int_0^{\pi/2} N_r \sin\theta_r \cos\theta_r \, d\theta_r \, d\phi_r}{N_i \sin\theta_i \cos\theta_i \, d\theta_i \, d\phi_i} \quad . \tag{1}$$

The relation between directional and bidirectional reflectance (BDR) is given by the integral of the latter over the viewing hemisphere

$$\rho_d = (\theta_i,\phi_i) = \int_0^{2\pi} \int_0^{\pi/2} \rho'(\theta_i,\phi_i;\theta_r,\phi_r) \sin\theta_r \cos\theta_r \, d\theta_r \, d\phi_r \quad . \tag{2}$$

[3] Nicodemus, F., "Directional Reflectance and Emissivity of an Opaque Surface", Applied Optics, Vol. 4, No. 7 (July 1965).

For a perfectly diffuse isotropic reflector ($\rho'(\theta_i,\phi_i;\theta_r,\phi_r)$ = constant), integration of (2) gives

$$\rho_d = \pi\rho' \quad . \tag{3}$$

4.2 Quantities Derived from Directional Reflectance

The measured directional reflectance of a surface may be used to compute two important properties required for radiative heat transfer analysis, viz. the directional emittance and the solar absorptance.

4.2.1 Emittance

By reasons of conservation of energy, the directional emittance of an opaque surface at a given wavelength and angle of incidence may be expressed by

$$\varepsilon_d(\theta_i,\phi_i,\lambda) = 1 - \rho_d(\theta_i,\phi_i,\lambda) \quad , \tag{4}$$

where $\rho_d(\theta_i,\phi_i,\lambda)$ is the measured directional reflectance. From this relation, the total directional emittance of the surface at a given temperature may be found by

$$\varepsilon_t = 1 - \frac{\int_0^\infty \rho_d(\lambda)\, P(\lambda,T)\, d\lambda}{\int_0^\infty P(\lambda,T)\, d\lambda} \quad , \tag{5}$$

where

$$P(\lambda,T) = \frac{8\pi hc}{\lambda^5(e^{hc/\lambda Tk} - 1)} \quad , \tag{6}$$

is Planck's Function for the given wavelength and temperature. Substituting values for the constants h, c and k and providing the appropriate unit conversion so λ can be expressed in microns we have

$$P(\lambda,T) = \frac{0.000119088}{\lambda^5[e^{14388/\lambda T} - 1]} \quad . \tag{7}$$

SOC software has been implemented to provide emittance data of three types, depending on the angular coverage present in the reflectance measurements:

(a) directional, near-normal emittance, when reflectance has been measured at near-normal incidence ($\theta = 20°$);

(b) directional angular emittance, when reflectance has been measured at any incidence angle other than near-normal;

(c) total hemispherical emittance, when reflectance has been measured over a sufficiently wide range of incidence angles to permit integration over the hemisphere, viz.

$$\varepsilon_{H} = 2\int_{0}^{\pi/2} \varepsilon_{d}(\theta)_{T} \sin\theta \cos\theta \, d\theta \quad . \tag{8}$$

4.2.2 Solar Absorptance

According to Kirchhoff's Law, the absorptance of a surface at any wavelength is equal to its emittance

$$\alpha_{\lambda} = \varepsilon_{\lambda} \quad . \tag{9}$$

The solar absorptance of the surface may therefore be written as

$$\varepsilon_{s} = \frac{\int_{\lambda_1}^{\lambda_2} \varepsilon_{d}(\lambda)\, J(\lambda)\, d\lambda}{\int_{\lambda_1}^{\lambda_2} J(\lambda)\, d\lambda} \quad , \tag{10}$$

where $J(\lambda)$ is the solar irradiance function. SOC program SOLARAB calculates the exoatmospheric solar absorptance of a surface from the measured directional reflectance and the NASA solar spectrum SP-8005, modified to give a solar constant of 1368 (watts/M^2). The computational procedure selects points of the solar irradiance function which match the wavelengths of the measured reflectances, using interpolation where necessary. The program is capable of utilizing directional reflectance data obtained over the full range of angles of incidence.

4.3 Transmittance

A transmissive material may transmit electromagnetic radiation in one of the following two ways. First, as a collimated beam of light propagates through the material it may be scattered into a hemisphere of 2π steradians upon exiting the material. Material that exhibits this type of property (scattered transmittance, T_s) is called translucent.

Secondly, if the transmitted beam is parallel to the incident beam across the width of the entire beam, the transmittance is referred to as collimated transmittance, T_c. Materials of this type are called transparent.

These distinctions are important since they determine how both the absorptance of a transmissive material is calculated and how the transmittance is measured.

$$\alpha = 1 - \rho_d - T_s \text{ (translucent material)} \ , \tag{11}$$

$$\alpha = 1 - \rho_d - T_c \text{ (transparent material)} \ . \tag{12}$$

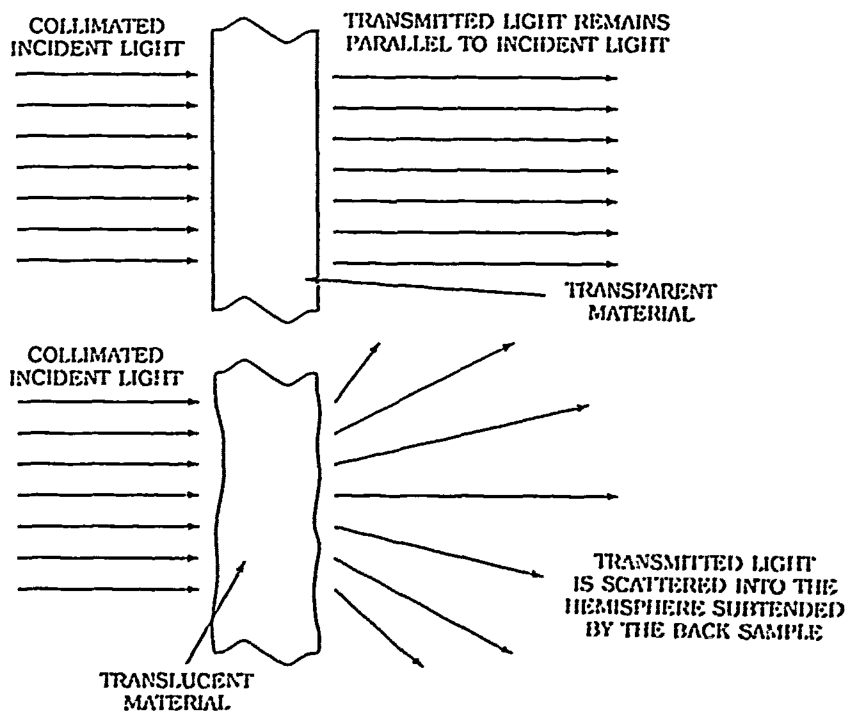

Figure 5. Transmittance of Transparent and Translucent Materials.

4.4 Bidirectional Reflectance

The bidirectional reflectance (BDR) of a surface is defined as the ratio of the luminous radiance reflected into a unit solid angle to the total radiance incident. As illustrated by the diagram of Figure 6

$$\rho'(\theta_i,\phi_i,\theta_r,\phi_r) = dN_r/(N_i \cos\theta_i \, d\omega_i) \quad , \tag{13}$$

where $d\omega_i = \sin\theta_i \, d\theta_i \, d\phi_i$, and dN_r is the reflected portion of radiance in the direction (θ_r,ϕ_r) due to a source of radiance N_i in the direction (θ_i,ϕ_i).

The dimension of BDR is reciprocal steradians. Note that its value may be larger than unity.

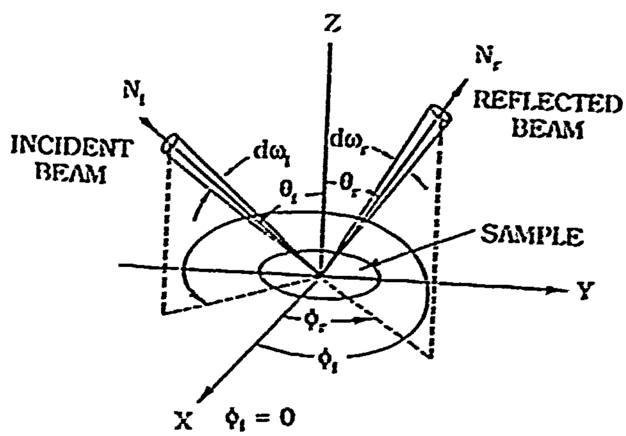

Figure 6. Diagram Illustrating Concept of Bidirectional Reflectance.

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5.0 EXPERIMENTAL MEASUREMENTS

5.1 Directional Reflectance

The directional units which covers the wavelength band from 0.3 to 1.6 μm is called the Cary-Integrating Sphere Reflectometer and the device which covers the band from 1.6 to 25.0 μm (and beyond if required) is called the Infrared Reflectometer.

There are two methods which may be employed in directional reflectometer design. The "direct method", wherein the sample is illuminated from a specified direction and the scattered (reflected) radiation is collected and detected. Alternatively, using the "reciprocal", the sample may be uniformly illuminated by a hemisphere which the sample subtends and the scattered radiation from the sample at a specified direction is collected and detected. Both the directional reflectometers described here use the latter method.

5.1.1 Cary-Integrating Sphere Reflectometer

This instrument is designed for directional reflectance measurements in the near ultraviolet, visible and near infrared region. As illustrated in Figure 7 the sample is located at the center of a hollow 9" diameter sphere which is coated with a thick layer of Halon (G-80 tetrafluoretheylene).

The source illumination for the sample is provided by a 55 watt halogen bulb mounted behind the sample in the center of the integrating sphere. A diffuse reflector physically blocks the region between the sample and the bulb such that light from the halogen bulb must bounce off the integrating sphere a minimum of two times before reflecting off the sample surface. Thus, the sample views a uniformly illuminated hemisphere of 2π steradiancy. The angle of incidence θ_i at which the DR is measured may be varied by rotating the sample about an axis in the plane of the sample, the axis being perpendicular to the spectrophotometer beam. The azimuthal angle ϕ_i of the sample may be varied by rotation of the sample about the axis perpendicular to and through the sample center.

The beam reflected by the sample and a reference beam reflected by the illuminating hemisphere enter the collection optics of a Cary Model 14 Spectrophotometer. Here a rotating chopper alternately selects energy from the sample and reference beams, which is focussed onto a dispersing prism. The resulting monochromatic signals are directed to the appropriate detectors, a photomultiplier tube for the region from 0.3 to 0.8 μm, and a lead sulphide cell for that from 0.8 to 1.6 μm when measuring polarized data. The detector circuits automatically form the difference

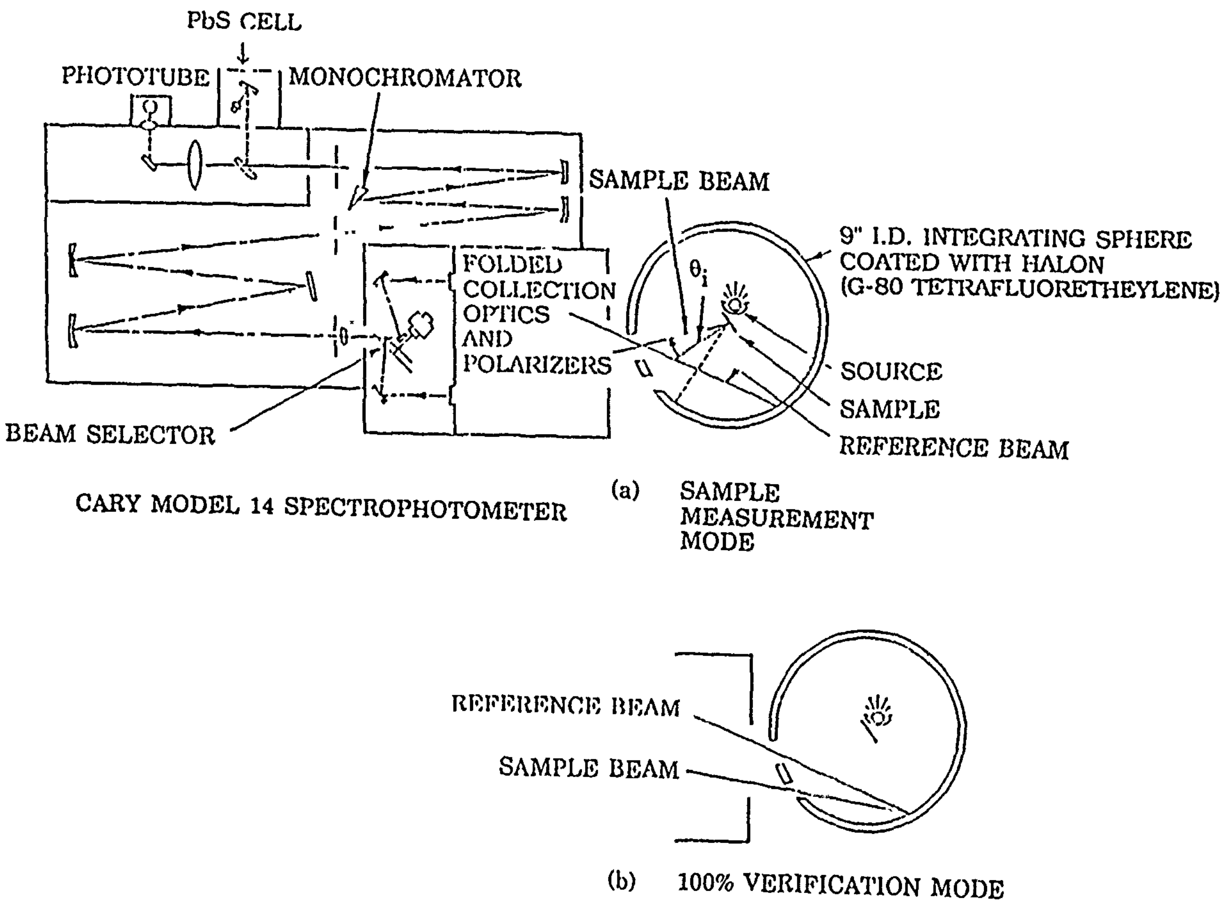

Figure 7. Schematic of Cary-Integrating Sphere Reflectometer.

of the two signals which is directly proportional to the directional reflectance (DR), and which is displayed as function of wavelength on a stripchart recorder. For internal calibration, the instrument is operated in the 100% or verification mode in which the two branches of the spectrophotometer collection optics view the same spot on the illuminating hemisphere. The principal features, components and performance characteristics of the instrument are shown in Table 3.

5.1.2 Infrared Reflectometer

From 1.6 to 25.0 µm and beyond, directional reflectance is experimentally measured using a hemi-ellipsoidal reflectometer. The features of this instrument are outlined in Table 4.

The characteristics of a hemi-ellipsoid are such that a point source of light emanating from one focus is imaged at the other focus.[4] The geometrical arrangement, in this case, of the source and sample at the foci in the plane of the ellipse, is shown in Figure 8. The source illuminates the sample uniformly over 2π steradians. The reflected radiation from the sample is viewed by a small spherical "overhead" mirror which directs the illumination in sequence to a plane mirror, a torroidal mirror, a plane mirror, thence to the monochromator slit, through the monochromator and to the detector, see Figure 8.

In the alignment process, the detector is replaced by a mercury arc source, and the Hg green line traverses the reflectometer optical path in the "reverse" direction. The monochromator entrance slit is imaged by the collection optics on a 1" diameter sample disc. The specularly and/or diffusely reflected slit image is in turn imaged by the hemi-ellipsoid into the IR source opening. The slit image on the sample (about 1/8" x 1/2") when reimaged by the ellipsoid on the source cavity, must fall completely within the confines of the IR cavity entrance. Given a uniform radiance from the cavity, uniform illumination of the slit image on the sample over 2π steradians is provided.[5] The large diameter (12") and closely spaced foci (2" separation) of the hemi-ellipsoid used make the geometric deviation from a hemisphere minimal, but this deviation is all important in minimizing the size of the diffusely reflected slit image at the cavity entrance, see reference 2.

To allow performance of required functions, it is necessary to rotate the overhead mirror, together with the collection optics, monochromator, and detector, in relation to the source, chopper, and sample system. The rotation is performed about an axis through the sample center, in the

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[4] W. M. Brandenberg, "Focusing Properties of Hemispherical and Ellipsoidal Mirror Reflectometers", Number DGA63-1111, ERR-AN-352, General Dynamics Astronautics Report, November 1963.

[5] Ibid.

Table 3

Cary-Integrating Sphere Reflectometer

Function	Determination of directional reflectance as a function of wavelength, angle of incidence, and light polarization in the near-ultraviolet, visible and near-infrared region.
Wavelength	0.2 to 1.6 µm.
Type	Integrating sphere coupled to Cary Model 14 dual beam prism-grating spectrophotometer.
Radiation Source	55 watt quartz halogen lamp, 3400° for 0.3 to 2.0 µm, and 30 watt Deuterium lamp for 0.2 to 0.3 µm.
Mode of Operation	Reciprocal: Uniform hemispherical illumination of sample. Sample viewing as a function of angle. Records traces for light polarized parallel (||) and perpendicular (⊥). The || and ⊥ traces are averaged to obtain reflectance for unpolarized light with effects of instrumentation polarization eliminated.
Sample Holder	Located in center of integrating sphere.
100% Value	Absolute measurement device, comparison to standard not required.
Transfer Optics	Custom design by Cary.
Polarizer	Dual Glan Thompson prisms (one in each beam) manufactured by Karl Lambrecht Corporation for ~ 0.3 to 2.0 µm, and UV dichroic sheet polarizer for 0.2 to 0.3 µm.
Viewing Angle	Near-normal (20°) to grazing (80°), with intermediate angles as required.
Detectors	Broadband response, phototube for 0.3 to 0.8 µm, lead sulfide for 0.8 to 1.6 µm, and PMT optimized for solarband region of spectrum, 0.2 to 0.3 µm.
Recording	Strip chart recorder.
Data Presentation	Graphical as a function of wavelength and incidence angle, tabular in ERAS format. Parallel and perpendicular polarized traces can be provided, with computed values of index of refraction (*n*) and extinction coefficient (*k*).

Table 4
Infrared Reflectometer

Function	Determination of directional reflectance as a function of wavelength, angle of incidence, and light polarization in the infrared region.
Wavelength	1.6 to 40 μm, coverage to 600 μm possible if required.
Type	Hemi-ellipsoidal: Ellipse cleavage plane contains semi-major and semi-minor axis. Infrared source at one focus, sample at other.
Infrared Source	High-purity, copper cavity with aerorod heater silver-soldered to outside, interior flame sprayed with a corrosion resistant alloy.
Chopper	Twin bladed, located between source and sample. Frequency, 20 Hz.
Mode of Operation	Reciprocal. Uniform illumination of sample, sample viewing as a function of angle. Records traces as f(λ) for light polarized perpendicular (⊥) and parallel (‖). Average (⊥) and (‖) traces to obtain reflectance for unpolarized radiation, i.e. with effects of instrumentation polarization eliminated.
Sample Holder	Water cooled carousel holds eight samples, individually positionable in sample measurement position.
100% Value	Absolute, or in comparison to high-reflectance evaporated gold reference sample.
Transfer Optics	Toroidal mirror $2\theta = 60°$, FL = 125 mm, used at 1 to 1 magnification.
Polarizers	Perkin-Elmer wiregrid and thin film (over ZnSe) infrared polarizers.
Monochromator	Perkin-Elmer model 210 grating. Available gratings: 1800, 640, 240, 101, 40, 20, 10, 5, and 1.25 lines/mm.
Viewing Angle	Near-normal (20°) to grazing (80°), with intermediate angles as required.
Detectors	PbS detector, 1.6 to 2.2 μm; pyroelectric detector, 2.2 to 40.0 μm.
Signal Processing	EG&G (PAR) #124 amplifier.
Recording	Digital voltmeter.
Data Presentation	Graphical, as a function of wavelength and incidence angle, tabular in ERAS format. If required, parallel and perpendicular polarized traces and computed n and k values.

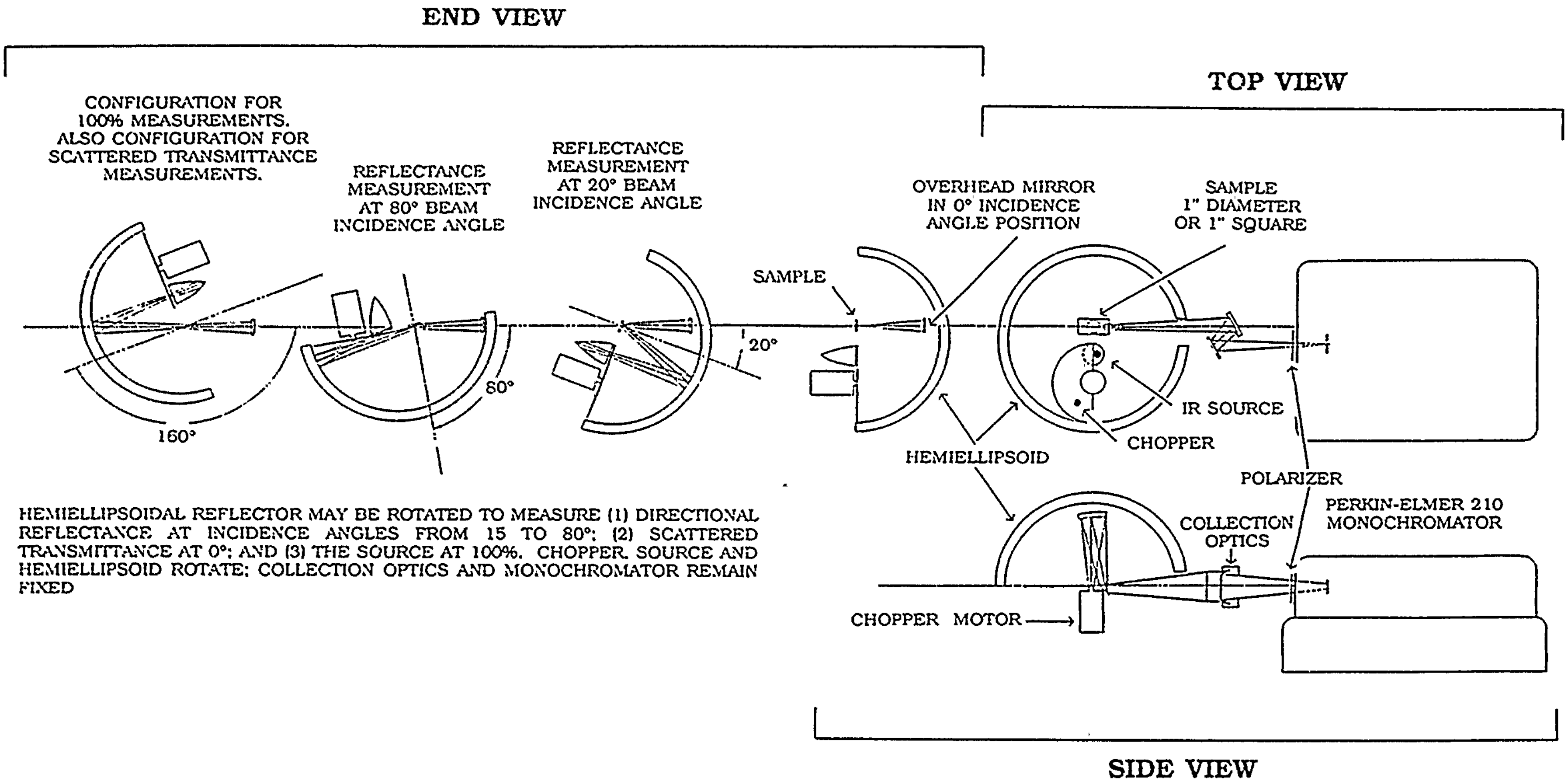

Figure 8. Schematic of Infrared Reflectometer.

plane of the sample and parallel to the ellipse semi-minor axis. This rotation is required (1) to allow positioning the mirror directly above the sample to measure the directional reflectance with the specular component eliminated, (2) to allow reflectance measurements as a function of angle 20 to 80°, and (3) to make a 100% measurement without use of a reference standard. The scattering or zero incidence angle measurement (specular component eliminated) is discussed below in Section 5.1.3. With this mechanism, angular measurements are routinely made for near-normal (20°), to grazing at 80° or greater.

Directional reflectance is, by definition, the ratio of the total reflected radiation to the radiation incident at a specified angle. Energy recorded when the sample is viewed by the overhead mirror gives the reflected datum. The incident datum may be measured (1) directly (so-called absolute method) or (2) derived by a replacement of the sample with a standard of known reflectance, such as evaporated gold on a smooth fused silica substrate.

The absolute 100% measurement requires removing the sample from the measurement position and rotating the overhead mirror to a location below the plane of the ellipse, see Figure 8. In this location, the overhead mirror receives the light which falls on the sample position, thus allowing measurement of the 100% datum.

The positioning of the overhead mirror in relation to the sample location is an important feature of the reflectometer. It cannot be accomplished by simply rotating the overhead mirror alone. The entire optical train, overhead mirror, torroid, monochromator and detector must remain fixed in relationship to each other; if the overhead mirror rotates, the entire train has to be rotated. This is now actually feasible with design changes recently accomplished. But for solid (non-fluid samples), the source-sample holder-chopper system is rotated, as shown in Figure 8.

5.1.3 Directional Reflectance Error Analysis

The principal problem in directional reflectance measurements is the availability of suitable standards. Directional reflectometers should provide a correct reflectance value for a specularly reflecting sample, a diffusely reflecting (scattering) sample, or a sample which reflects part of the light into a specular lobe and scatters the remainder. Calibration standards which may be correlated with theory are generally specular reflectors. The problem of standards has been discussed in some detail in a SAMSO report by R.J. Champetier and G.J. Friese.[6] The report compiles work done to resolve discrepancies in directional reflectance (or directional emittance)

[6] Champetier, R.J., and Friese, G.J., "Use of Polished Fused Silica to Standardize Directional Polished Emittance and Reflectance Measurements in the Infrared", SAMSO Report TR-74-202, SAMSO, Los Angeles Air Force Station, Los Angeles, CA, 90054 (9 August 1974).

obtained on the same sample by three different laboratories. The preferred standard for the IR region is pure, highly polished (and therefore specular) fused silica. A second choice is evaporated gold on a polished glass substrate.

As already noted, SOC uses two instruments to cover the full spectral region from 0.2 to 40.0 µm. For both instruments, the error is estimated by comparison of measured reflectance with values established by the National Bureau of Standards (NBS) or with theoretical values calculated from n and k data in the literature.[6]

The alternate method of error determination, viz, the summation of individual errors, is reasonably straightforward except for evaluation of the uniformity of the radiant intensity in the 2π steradians region subtended by the sample. This problem is common to both the Cary-sphere and the ellipsoid.

5.1.3.1 Cary-Sphere

Five samples which are mixtures of Halon and carbon black sintered to a solid mass were prepared and standardized by the NBS. These samples were diffuse reflectors. The reflectance ranges in the wavelength band between 0.25 and 2.5 µm for each sample are as follows:

- Sample #2 - 0.031 to 0.018;
- Sample #7 - 0.241 to 0.170;
- Sample #10 - 0.512 to 0.462;
- Sample #13 - 0.755 to 0.727;
- Sample #17 - 0.913 to 0.982.

The same five samples were measured by SOC in the region from 0.3 to 2.0 µm on the Cary-sphere. The deviation of the measured reflectance from the NBS values was in general less than 1%, excepting for sample #2, which showed values 1.3% higher than the NBS data. In operation the instrument is routinely checked against a specular gold standard. In the region from 1.0 to 2.0 µm, the standard shows reflectances of 98.5% to 99.5%, in good agreement with theoretical values.

5.1.3.2 Ellipsoidal Reflectometer

Beyond 2.5 µm, no diffuse standards exist. In this region, SOC uses a fused silica standard, i.e. a specular reflector. Reflectances at selected wavelengths between 4.0 and 25.0 µm are

measured as a function of angle. Incident angles are 20, 30, 40, 50, 60, 70, 75 and 80°. The results are compared to values calculated from n and k (Reference 6). Examples of the experimental fused silica reflectance values are shown in Figure 9. The curves are labeled parallel (| |) and perpendicular (⊥) according to the usual polarization convention. Agreement between measured and theoretical data is seen to be good. The instrument is routinely checked against the fused silica sample after adjustments are made, after a new source is installed, or if no measurements have been made for more than two weeks. At 16 µm, the standard is measured at eight angles and in both perpendicular and parallel polarization modes and checked against theoretical values in Reference 6. The agreement in the average ⊥ and | | values is generally within 1% for angles from 20 to 70°; the 75 and 80° values may be in error by as much as 3%.

5.2 Bidirectional Reflectance

5.2.1 Bidirectional Goniometric Reflectometer

This instrument is designed to measure the fraction of incident light reflected by a sample into incremental solid angles over its field of view. It uses illumination from incoherent sources ranging from visible UV (0.3 µm) to far I.R. (25.0 µm), and permits measurements for any combination of incident and reflected angles over a hemispherical field of view, excepting for a small solid angle in which source and detector mirrors interfere. Because of this limitation, the measurements are confined to bistatic configurations. The principal components and operating features of the system are listed in Table 5.

Light from the source is interrupted by a chopper and directed toward the sample by a folded beam system which terminates in an off-axis paraboloidal mirror. This mirror projects a beam of parallel light onto the sample surface. The incident beam diameter is somewhat larger than the sample diameter and thus provides a certain degree of "over-illumination". The sample is viewed by a movable off-axis paraboloid which projects the light reflected by the sample onto the detector via a folded beam transfer system similar to that used for the incident light. Figure 10 shows a schematic of the instrument with its essential components.

The bidirectional reflectance of a surface is a function of four independent variables: incident azimuth angle ϕ_i and polar angle θ_i, and reflected azimuth angle ϕ_r and polar angle θ_r. To generate the desired values of these variables in a measurement, the instrument must provide four angular degrees of freedom. As illustrated by the partial schematic of Figure 11 the incident azimuth angle ϕ_i is established by rotation of the sample about an axis through its center and normal to its surface, while the incident polar angle θ_i is set by rotation of the incident beam paraboloid about an axis through the sample plane. The reflected azimuth angle ϕ_r is generated by rotation of the yoke mounting the detector assembly about the vertical sample axis, the reflected polar angle θ_r by tilting the detector assembly about an axis containing the sample plane.

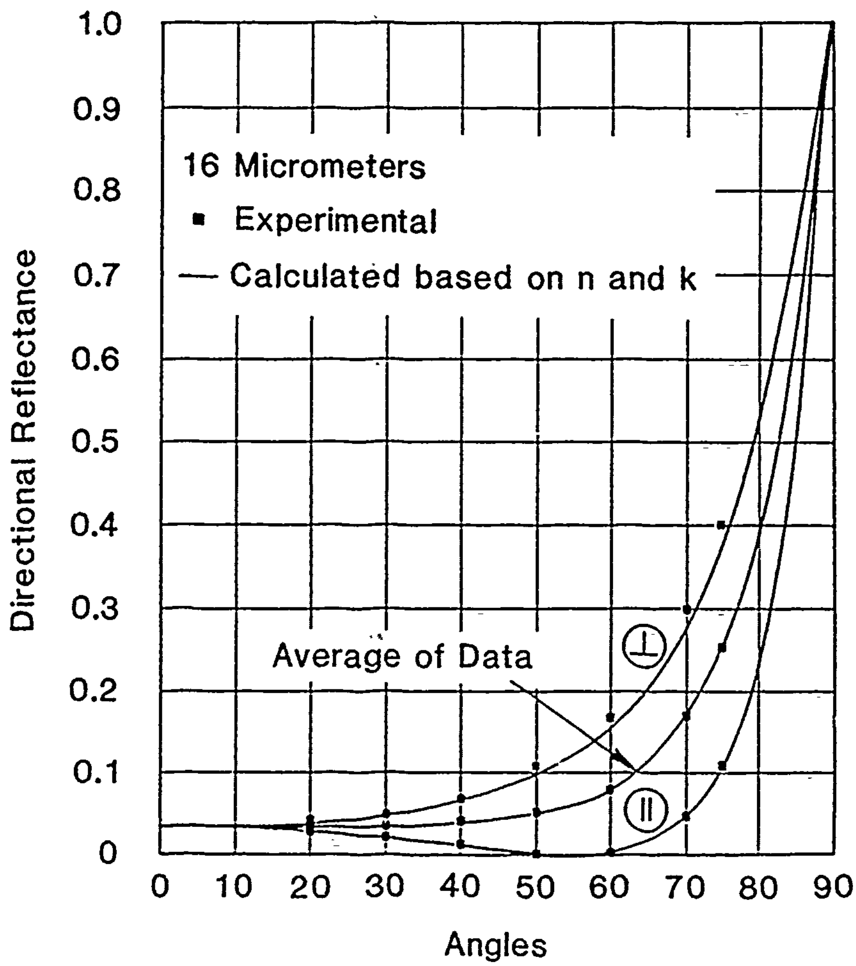

Figure 9. Directional Reflectance of Fused Silica Standard at 16 μm - Perpendicular (⊥), Parallel (| |), and Average.

Table 5
Bidirectional Reflectometer

Function	Determination of bidirectional reflectance at selected wavelengths in the ultraviolet, visible and infrared regions.
Wavelength	0.3 to 25.0 μm.
Type	Goniometer. Parallel beam illumination and detection. Incident polar angle variable 0 to 88°; reflected polar angle variable 0 to 88°, incident and reflected azimuth variable 0 to 360°.
Sources	UV to visible: mercury or xenon short arcs. IR: 2000 K blackbody.
Chopper	Brower, variable frequency.
Mode of Operation	At a given wavelength illuminate sample from 0 to 88° with parallel beam, detect with parallel beam in 2π steradians hemisphere over the sample. Determine BDR by (a) comparing detector signal of sample to that of a diffuse gold standard, or (b) by summing all relative BDR values and equating the sum to the independently determined DR of the sample.
Sample Holder	Stem-mount.
Transfer Optics	Two off-axis parabola mirrors used at 1 to 1 magnification. Sample beam rendered parallel using parabola from Perkin-Elmer spectrometer.
Light Dispersion	Thin film interference filters.
Detectors	Phototube. Thermoelectrically, helium and LN2 cooled detectors: ZnGe, PbS, PbSe, InSb, HgGe, CuGe, MCT.
Signal Processing	Detector preamplifiers and EG&G (PAR) #124 amplifier.
Recording	Digital volt meter.
Data Presentation	Graphical as a function of angles, tabular in ERAS format.

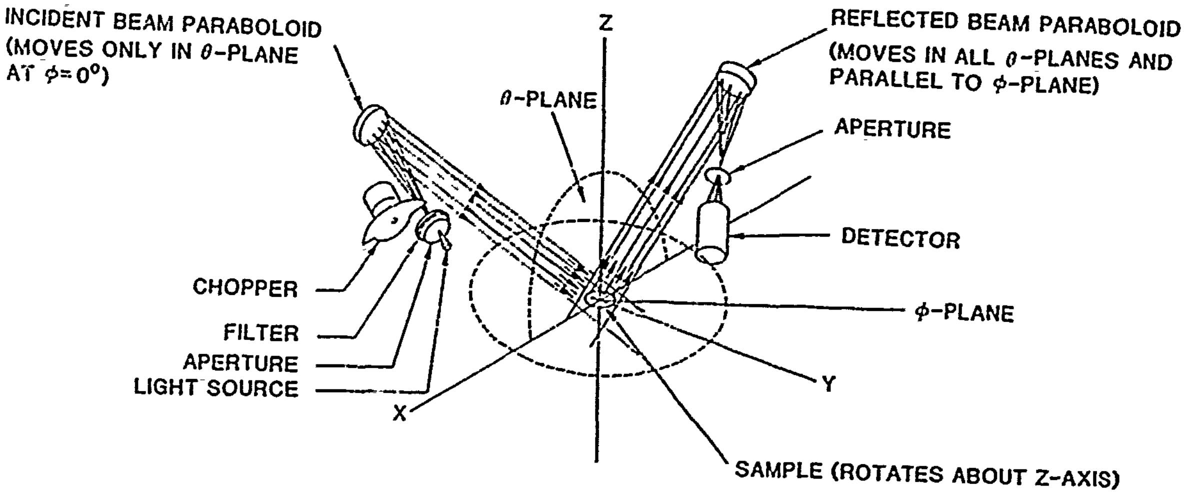

Figure 10. Schematic of Bidirectional Goniometric Reflectometer.

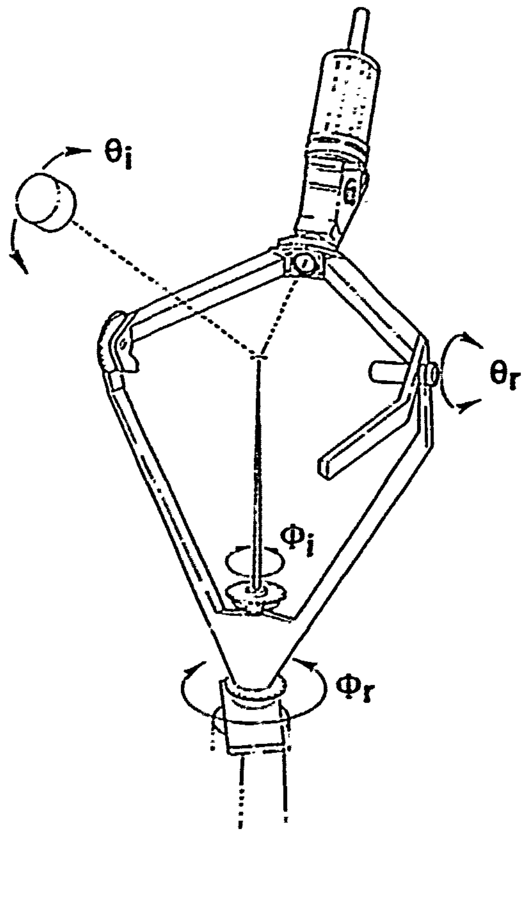

Figure 11. Goniometric Structure of Bidirectional Reflectometer.

The relative bidirectional reflectance is measured at closely spaced angular positions over a range of incident θ_i angles. For samples with isotropy about the normal, it is not necessary to vary ϕ_i. However, if the sample has surface structure which exhibits a preferred (as opposed to random) direction, then the BDR may vary significantly as a function of ϕ_i, in this case, BDR measurements at several incident azimuth angles are required.

All measurements are made in the relative mode, either by comparison with a diffuse gold standard, or by summation of all relative BDR values and comparing the total to the measured DR value. In the second method, the first step is to form the ratio of the light reflected in a given direction to that reflected at a reference angle, e.g. the specular angle. This relative reflectance is mapped at a large number of individual angles over the entire 2π steradiancy subtended by the sample. Next the sum of the relative bidirectional reflectances is set equal to the total directional reflectance measured previously (see section 4.1). The individual bidirectional reflectances are then obtained by algebraic manipulation.

The various bidirectional reflectance determination methods may conveniently be divided into two categories: complete mapping and selective mapping.

5.2.1.1 Complete Mapping

Complete mapping may be provided by methods which equate a full set (full mapping of the hemisphere) of relative bidirectional reflectance values to the directional reflectance of the sample. By relative bidirectional reflectance is meant the ratio of the light reflected in a given direction to light reflected at a reference angle such as the specular angle. This complete bidirectional reflectance mapping method is useful in predicting vehicle signatures from faceted models. The mapping of the reflectance into a hemisphere may be done entirely experimentally to provide the most accurate representation or using the SYNTHET method which computes the full mapping from limited experimental data. The former method is referred to as complete experimental mapping, the latter as SYNTHET.

5.2.1.2 Selective Mapping

There are a variety of selective mapping methods which have been devised for particular requirements. These methods all have in common the use of a diffuse bidirectional reflectance standard which was experimentally standardized by complete experimental mapping as defined above. In this project, the "in-plane, cross-plane, ring" method was selected by SSI.

Using this method, polar scans at 20, 40, and 60° are performed at azimuthal angles ϕ_r = 180, 90 and 0°. In addition, a ring scan is also made by holding $\theta_r = \theta_i$ and varying ϕ_r from 180°

to as close to 0° as possible. Physical limitations of the instrument make the ring measurement at $\phi_r = 0°$ impossible. Figures 12 (a), 12 (b) and 12 (c) illustrate these scans. For each scan, a standard is measured to allow conversion of the relative values to absolute Sr^{-1} values.

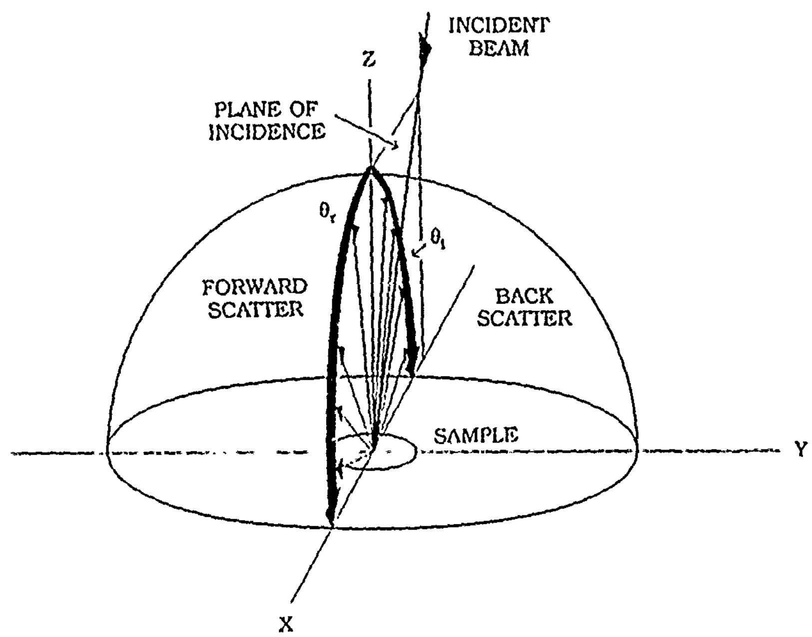

Figure 12 (a). In-Plane Scan.

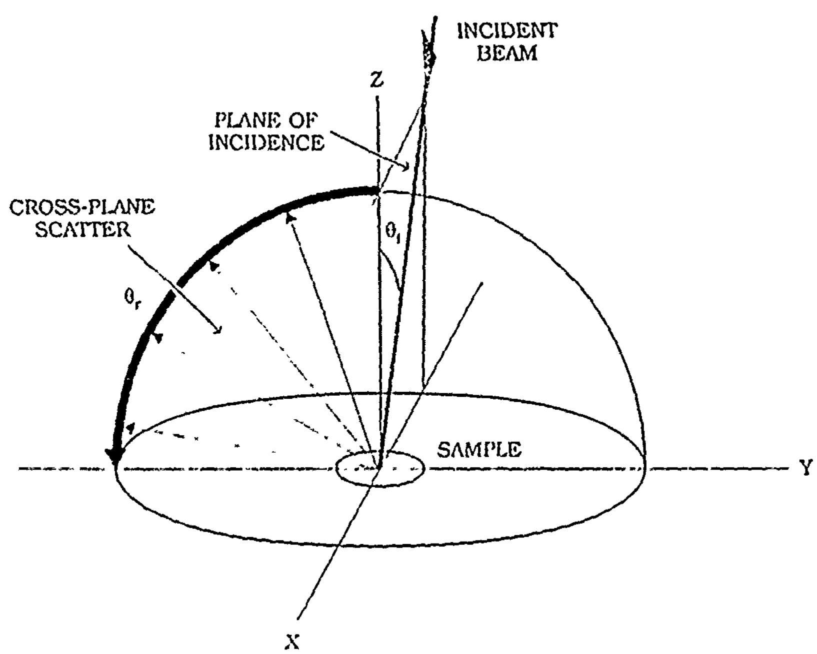

Figure 12 (b). Cross-Plane Scan.

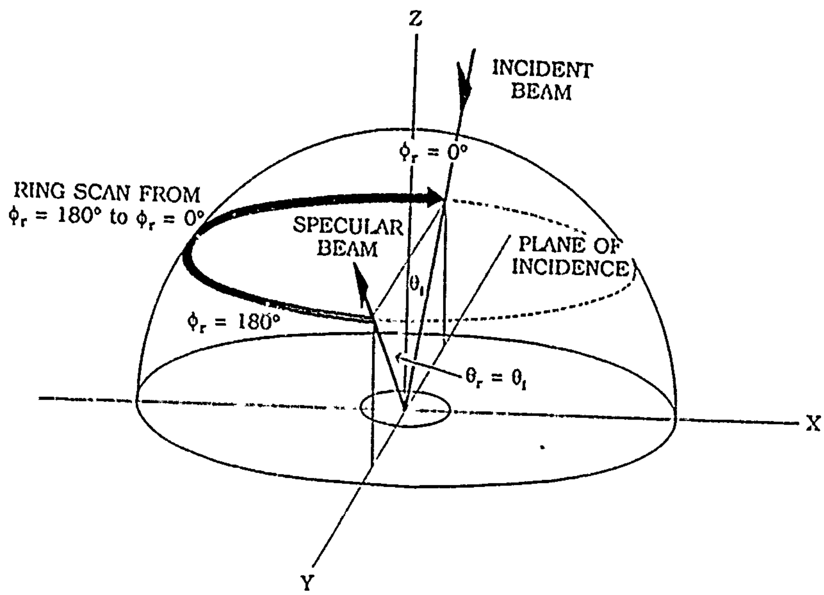

Figure 12 (c). Principal Ring Scan.

5.2.2 Bidirectional Reflectance Error Analysis

The principal error sources in BDR measurements have been defined as follows:[7]

(1) Spectral bandwidth of interference filter.
(2) Finite solid angle of source and detector.
(3) Uncertainty in angle measurement.
(4) Variation in source intensity and detector response.
(5) Polarization of incident energy.
(6) Energy scattered from surroundings.
(7) Energy scattered from sample edge.
(8) Uncertainty in directional reflectance.

The contributions of these errors to the overall error in the BDR measurements are estimated as follows:

(a) The interference filters employed cover a variety of spectral bandwidths. Since no measurements are made near an absorption edge, the BDR value taken within this spectral

[7] Brandenberg, W.M., and Neu, J.T., "Unidirectional Reflectance of Imperfectly Diffuse Surfaces", J.O.S.A., Vol. 56, No. 1, 97-103 (January 1966).

band may be considered to be constant, and the contribution due to this effect is essentially negligible.

(b) The variation of BDR within the solid angle aperture of either source or detector is primarily dependent on the nature of the surface. For most imperfectly diffuse surfaces the BDR changes negligibly within small increments in solid angle. For smooth surfaces a more rapid change is apparent around the specular angle. Measurements of the angular divergence of the detector beam as a function of source aperture width show that the angular divergence can be limited to 0.1° (see Figure 13).

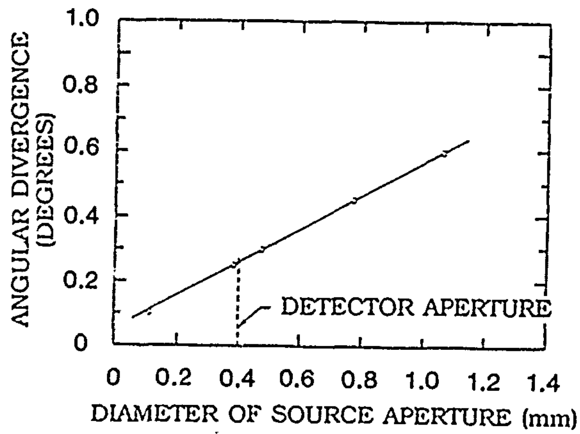

Figure 13. Angular Divergence of Detector Beam as a Function of Source Aperture.

Reflectance measurements on a polished aluminum sample have shown the angular halfwidth of the BDR around the specular peak to be in the order of 1.3° (Figure 14), i.e. more than ten times larger than the limiting angular divergence. The error due to uncertainty in reflected and incident angles is negligible, except for highly specular surfaces and can be held to 0.02° with proper care in angular measurement.

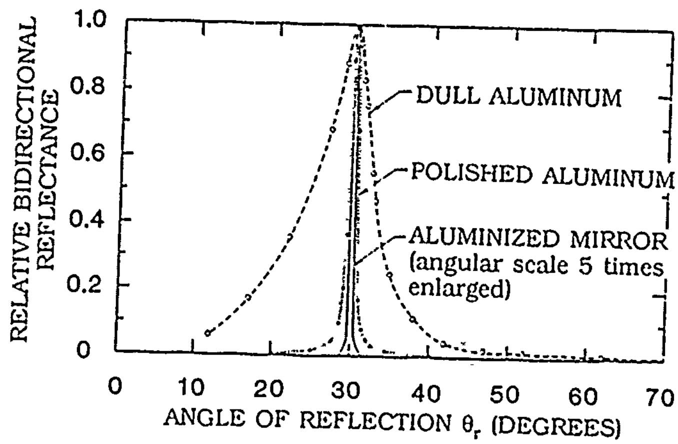

Figure 14. Relative Bidirectional Reflectance of Dull and Polished Aluminum as a Function of the Reflected Angle θ_r at $\lambda = 0.507\ \mu m$.

The effects of source intensity fluctuation and random detector variations are minimized by statistical sampling procedures. for the source, an RMS error is calculated from the maxima and minima of readings taken over a given time period at each wavelength. Typically the maximum error occurring at 10.6 μm is 1.4% of the average. Similarly, the RMS error in detector response is calculated from maxima and minima BDR readings taken over a given time interval at the specular angle and at each wavelength.

The effect of polarization of the incident beam is generally small for bidirectional reflectance of most surfaces. Hence, the bidirectional reflectance may usually be measured without separate measurements of the two polarizing components. As an example, it was found that, at a wavelength of 0.507 μm, the intensity of the source in the two polarizing modes differs by about 1.5%. But if the bidirectional reflectances measured separately for each mode differ by, say, 10%, the difference between the mean of the two values and the directly determined BDR is less than 0.15%. Hence the error due to polarization in the incident energy is negligible.

Errors due to energy scattered into the detector by the surroundings are minimized by over-illumination of the sample and are negligible in all cases. This very procedure, however, can produce scattering by the sample edge. If the incident polar angle is small, the projected area of the sample edge is small compared to that of the sample surface. At larger incidence angles and with thick samples a black shield around the edge is necessary to eliminate the scattering effect.

To estimate the relative error of the bidirectional reflectance ρ' due to uncertainty in directional reflectance ρ_d and uncertainty in the recorder reading ΔV, the general relation between DR and BDR is expressed in the form

$$\rho_d = (\theta_i,\phi_i) = \int_0^{2\pi} \int_0^{\pi/2} \rho'(\theta_i,\phi_i;\theta_r,\phi_r) \sin\theta_r \cos\theta_r \, d\theta_r \, d\phi_r \quad , \tag{14}$$

where ρ_d is the DR, ρ' the BDR, θ_i and ϕ_i are the incident polar and azimuth angles, and θ_r and ϕ_r are the reflected polar and azimuth angles. In a measurement, the BDR is proportional to a voltage signal V, viz.

$$\rho'(\theta_i,\phi_i;\theta_r,\phi_r) = \frac{kV(\theta_i,\phi_i;\theta_r,\phi_r)}{\cos\theta_r} \quad , \tag{15}$$

and the DR can then be written in the form

$$\rho_d = \int_0^{2\pi} \int_0^{\pi/2} kV(\theta_i,\phi_i;\theta_r,\phi_r) \sin\theta_r \, d\theta_r \, d\phi_r \quad . \tag{16}$$

Dividing equation (15) by equation (16) gives

$$\rho'(\theta_i,\phi_i;\theta_r,\phi_r) = \frac{\rho_d \, V(\theta_i,\phi_i;\theta_r,\phi_r)}{\cos\theta_r \int_0^{2\pi} \int_0^{\pi/2} V(\theta_i,\phi_i;\theta_r,\phi_r) \sin\theta_r \, d\theta_r \, d\phi_r} \quad . \tag{17}$$

It must be noted that in a measurement the voltage signal is measured at discrete angular increments, and that the BDR is assumed to remain constant over the incremental solid angle of the reading. Equation (17) may then be written in the form

$$\rho' = \frac{\rho_d \, V(\theta_i,\phi_i;\theta_r,\phi_r)}{\cos\theta_{rn} \, \Sigma \, \Sigma \, V(\theta_i,\phi_i;\theta_r,\phi_r) \sin\theta_{rn} \, \Delta\theta_{rn} \, \Delta\phi_{rm}} \quad , \tag{18}$$

where r and n are the angular increments of incident polar and azimuth angles, m and n the angular increments in reflected azimuth and polar angles, and M and N are the limits of integration over the hemisphere, 2π and $\pi/2$, respectively. The choice of angular increments depends upon the type of surface, they must be taken small near the specular peak of a smooth surface where the return signal V changes rapidly with the polar angle. For diffuse surfaces, the angular increments may be made larger without affecting the accuracy.

From equations (17) and (18) the relative error in BDR has been calculated as

$$\frac{\Delta\rho'}{\rho'} = \pm \{(1 + \frac{2}{\pi} \frac{\rho'}{\rho_d} \cos\theta_r) \frac{\Delta V}{V} + \frac{\Delta\rho_d}{\rho_d}\} \quad . \tag{19}$$

In this relation the accuracy in recorder reading is estimated as 0.015 of full scale deflection. The relative accuracy in directional reflectance is in the order of 0.03 for the instruments currently in use at SOC.

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6.0 DATA REDUCTION AND PRESENTATION

Data reduction is by interactive means, using a Sun 3/260 computer with a CRT terminal (CIT-101) and laser printer within the SOC laboratory facility. Current working sets of data are stored entirely within the computer where they are immediately available to the terminal display, either as print-out in report-ready format or graphical presentation. This procedure has eliminated the use of keypunch formats. Another advantage is the speed with which data on new materials can be acquired, processed and transferred. If required, the system provides computer-to-computer transfer between the SOC site and a client's facility via telephone lines.

6.1 Codes for Data Reduction

Data obtained with all incoherent source instrumentation (Cary-Integrating Sphere, Infrared Reflectometer, Bidirectional Reflectometer) are processed by an interactive prompting system which eliminates the use of keypunch formats. For the directional reflectance measurements, the programs automatically merge the data collected by the Cary-Integrating Sphere and the Infrared Reflectometer. The flow for processing is shown below.

6.1.1 Directional Reflectance Codes

Cary data (directional reflectance 0.3 to 1.6 μm) are read from the instrument charts and entered into the computer by means of a prompting system. Infrared data (DR 1.2 to 40.0 μm) are read from digital voltmeter printer tape and entered by prompting at each wavelength of interest. The raw data are processed into reflectance data and formatted to the standard ERAS form[8]. Two different classes of data are recognized. These are:

1. near-normal, unpolarized data (used largely for thermal analysis calculations),

2. angular data collected in both polarizations (used as a data base for signature calculations).

The following types of data may be generated, depending on requirements:

[8] Earing, Dianne, "Support Information for Target System Measurements", Willow Run Laboratories, Institute of Science and Technology, The University of Michigan, December 1967.

1. solar absorptance as a function of polar incidence angle;

2. integrated directional emittance as a function of temperature and angle, and total hemispherical emittance;

3. directional reflectance as a function of wavelength and angle (including perpendicular and parallel polarization branches and their average);

4. "bestfit" values of index of refraction and extinction coefficient;

5. "bestfit" Brewster angle.

Figures 15 and 16 show the data reduction program entities involved in the two classes of reduction.

6.1.2 Directional Transmittance Codes

Directional transmittance data obtained with the Cary and infrared reflectometer in either the scattered or collimated mode are processed in the same manner as unpolarized directional reflectance data, Figure 17.

6.1.3 Bidirectional Reflectance Codes

Raw bidirectional reflectance data are entered into the computer from a digital voltmeter printer tape in a standard format using the terminal tabs for spacing. Bidirectional reflectance data collected as relative values over the hemisphere above the sample are normalized to BDR (1/ster) by integration using a measured value of directional reflectance at each incident angle and wavelength. Gaps in the data caused by goniometer arm interference are filled by interpolation. Checks are performed to assure that scattered energy over the hemisphere integrates to the measured directional reflectance. Figure 18 shows the steps in the reduction.

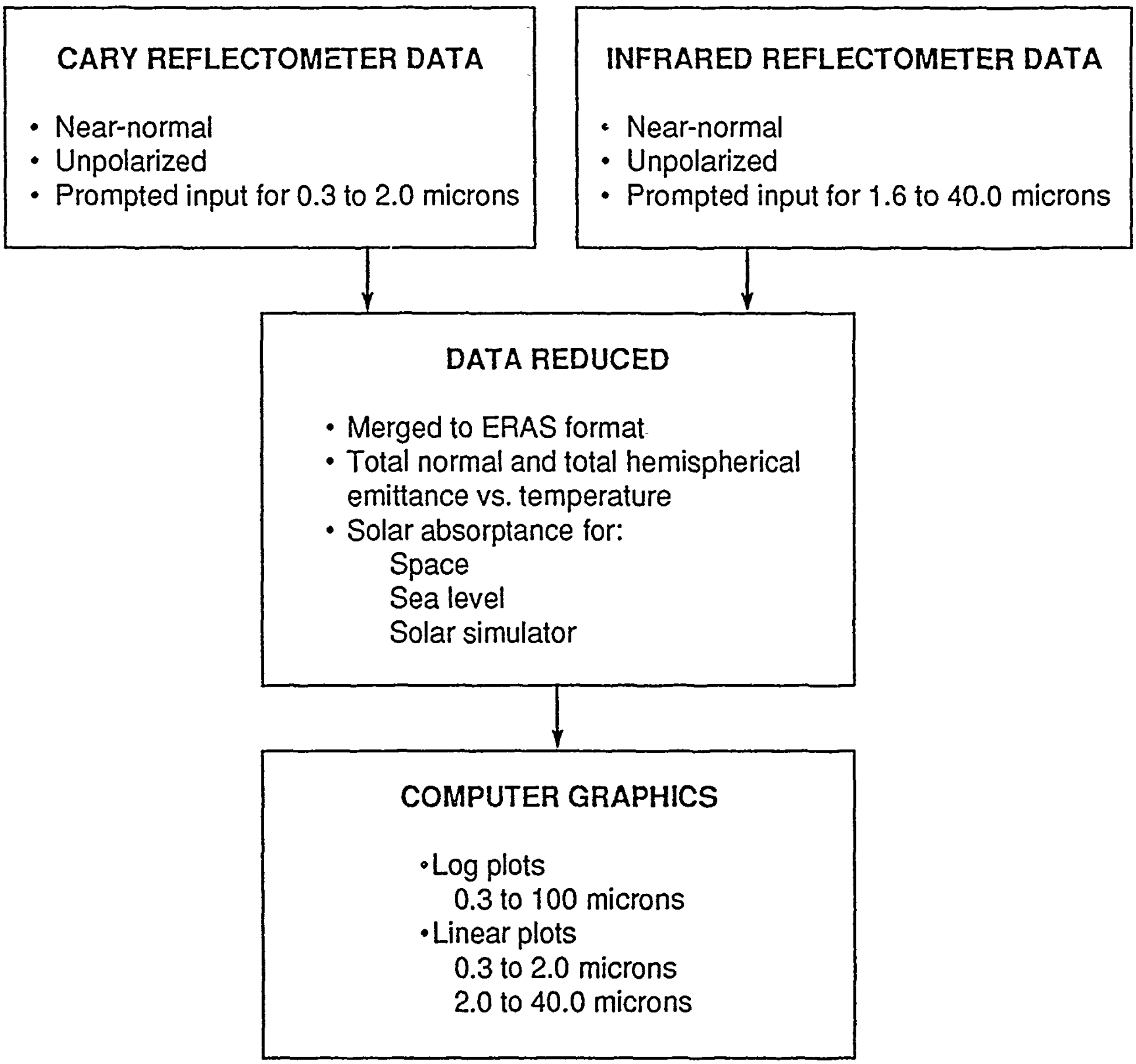

Figure 15. Directional Reflectance Data Processing for Thermal Analysis Calculations.

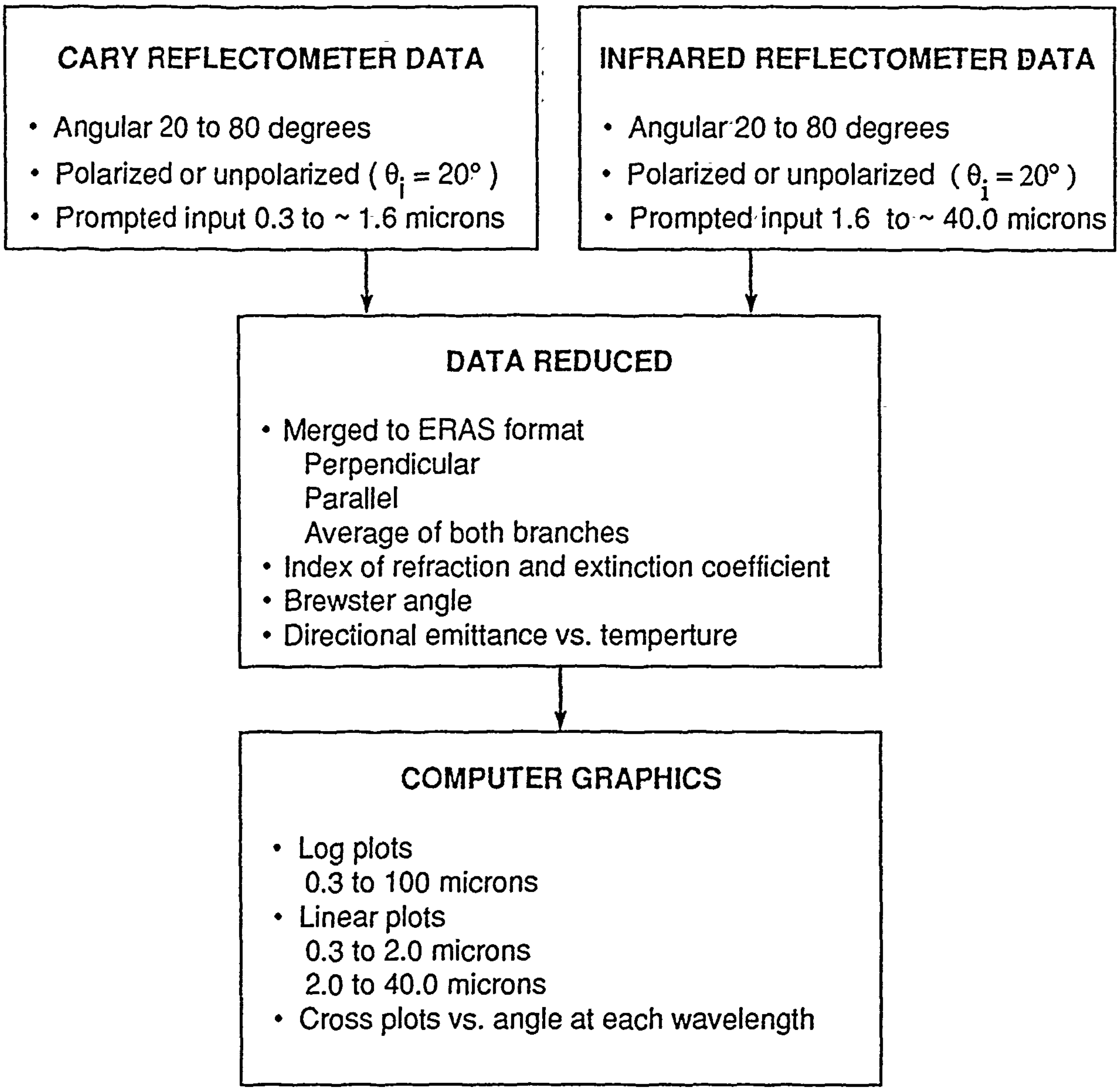

Figure 16. Directional Reflectance Data Processing for Signature Calculations.

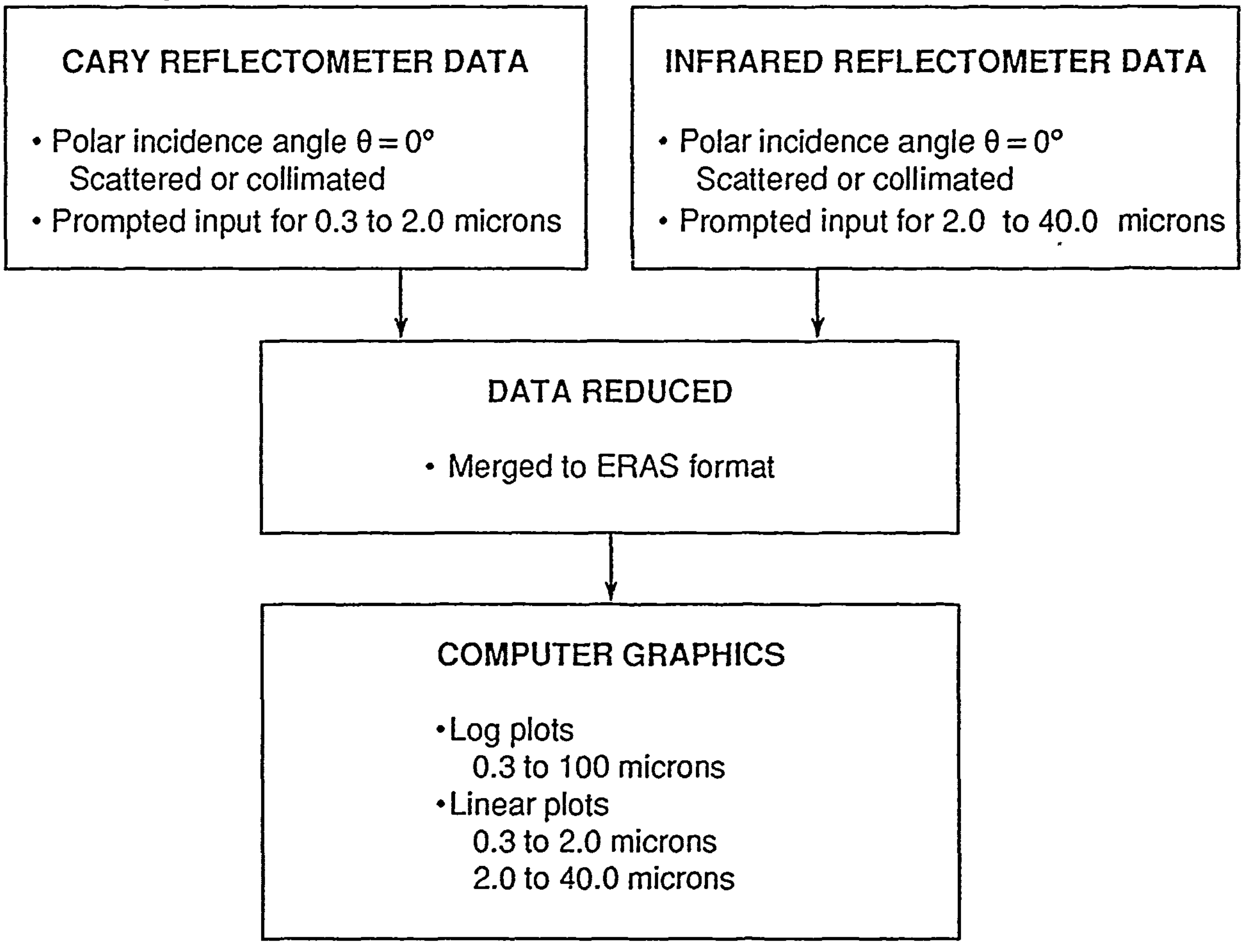

Figure 17. Directional Transmittance Data Processing.

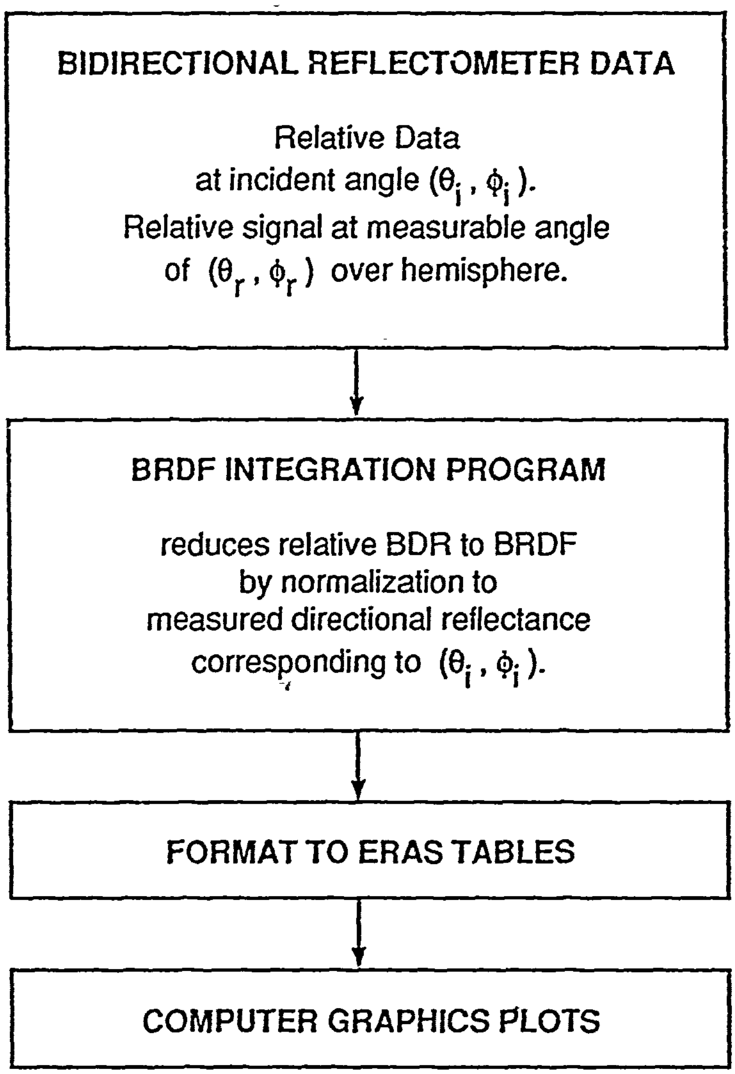

Figure 18. **Bidirectional Reflectance Data Processing.**

6.2 Data Presentation

Data is presented in both graphical and tabular form. In both cases special software is used. The tabular data is compiled in accordance with the ERAS format. In addition, all ERAS formatted data can be provided on tape.

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7.0 ANALYSIS

7.1 Introduction

Twenty-four (24) separate samples were measured by Surface Optics Corporation (SOC) for Spectral Sciences, Inc. (SSI). The measurements were broken up into two separate phases. In the first phase two tree bark samples and a leaf sample, both top and bottom, were fully characterized with directional reflectance (DR) and bidirectional reflectance (BDR) measurements. The samples for the first phase arrived on 12 September 1990; measurements commenced on the 13th of September and were completed on 1 October 1990. The leaf samples for the first phase were shipped in "rose bud" holders which kept the base of the stems immersed in water at all times. This allowed the leaves to stay fairly fresh over the course of the two and one-half week period when measurements were performed.

In the second phase a large number of leaf samples were received by SOC on 19 October 1990 and sixteen (16) samples, eight from the top of the leaf and eight from the bottom, were cut and mounted for DR measurements from 0.3 to 26.0 µm at 20° incidence. These scans were performed on 19 October 1990 when the leaves were fresh and again on the 22nd of October after the leaves were allowed to dry for three days at room temperature. In addition to the DR measurements, four additional samples were cut from this second set of leaves and the scattered transmittance at 0° incidence was measured from 0.3 to 26.0 µm on the 23rd of October. The leaf samples for the second phase were shipped with wet paper towels wrapped around the stems and not the "rose bud" holders received with the first set of leaves. For this reason the second batch of leaves deteriorated at a much faster rate than the leaves from the first shipment.

7.2 Sample Mounting

Due to the rigidity of the two bark materials, these samples did not have to be mounted on a substrate. The bark samples were made by cutting a one inch square from the raw material.

The leaf samples were mounted over a one inch diameter metal substrate. The substrate consisted of a brass disk covered with an opaque adhesive coating composed of a mixture of Mikron™ black paint and epoxy. The leaf was then placed on top of the Mikron black and epoxy mixture and allowed to dry over a period of one hour. The reasons for mounting the leaves on this substrate are twofold. First, the leaves are not rigid enough to place directly into the instrument, and secondly, the combination of Mikron black and epoxy yields very low reflectance values from 0.3 to 26.0 µm thus reducing errors in the DR due to reflections off the substrate. This low reflectance substrate minimizes the amount of transmitted energy that reflects off the backing

which is then transmitted through the sample face contributing to the overall reflectance of the sample. This net contribution always increases the observed reflectance and is thus considered an error. Section 7.7 discusses this concept in greater detail.

7.3 Sample Orientation

After mounting the samples, it was necessary to define and record the incident azimuthal orientations (ϕ_i) for the sample. For the bark samples, 0° incident azimuth was chosen to correspond with the vertical direction of the bark as it exists on the tree. This choice was aided by the fact that the bark had noticeable striae on the back side in the vertical direction and further confirmed by the fact that the individual responsible for cutting the samples cut them such that the longest dimension remained parallel to the vertical direction.

For the leaf samples the 0° incident azimuth was chosen to lie along the main vain of each leaf. It should be noted that the leaf samples were not always chosen with the main vain running through them. Figures 19 and 20 illustrate the azimuthal orientation defined for the bark and leaf samples.

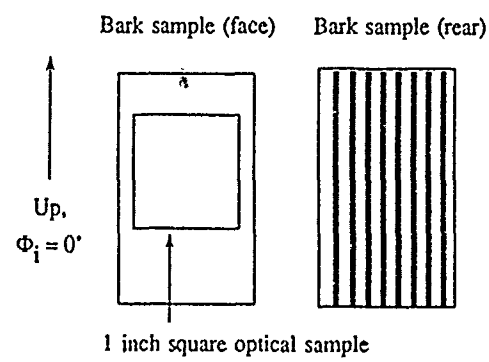

Figure 19. Schematic Showing Orientation of Bark Sample.

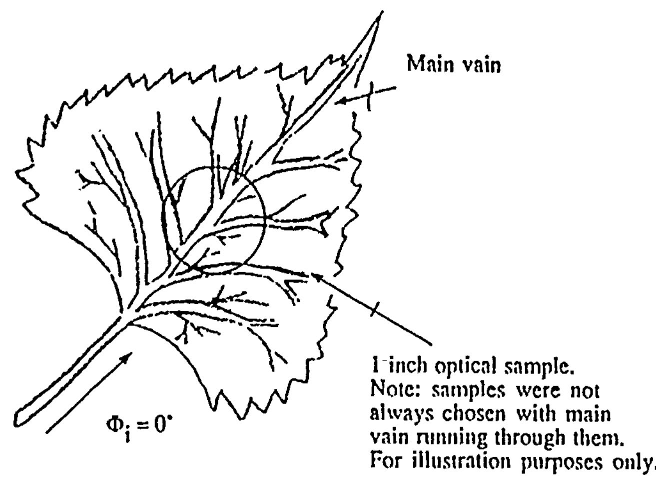

Figure 20. Schematic Showing Orientation of Leaf Sample.

For the second phase of the program, the 16 leaf samples (8 top and 8 bottom) were chosen randomly off the leaves and were all oriented with the 0° incident azimuth aligned along the main vain (as in Phase I). (For a more detailed discussion see Section 7.6.)

7.4 Dependence of Reflectance on Orientation

For the first phase of this program both the bark and the leaf samples were scanned at 20° from 0.3 to 10.0 μm (bark), and from 0.3 to 25.0 μm (leaves) at incident azimuths of 0 and 90°. This was done to determine if there was any significant difference between the DR at these two orientations for a particular sample. Figures 21 through 28 show the results of these scans. It can be seen that there is no appreciable difference in DR between the two orientations except in the case of FS4833 (bark sample #1). These differences occur in the band from ~ 0.75 μm to ~ 1.80 μm, with the maximum difference around 1.275 μm (~ 5.5% difference). Sample FS4833 did not appear very homogeneous but rather somewhat spotted due to fungi growths. Since the reflectometers measure the reflectance over a narrow rectangular area centered on the sample, when the samples are rotated the rectangular area falls on a different region of the sample. If the sample is not homogeneous then one can expect differences in the directional reflectance that are a result of the nonhomogeneous nature of the sample. It is believed that this is the case for FS4833. As a result there appears to be no noticeable DR dependence on the incident azimuthal direction for the near-normal data.

DIRECTIONAL REFLECTANCE VERSUS WAVELENGTH

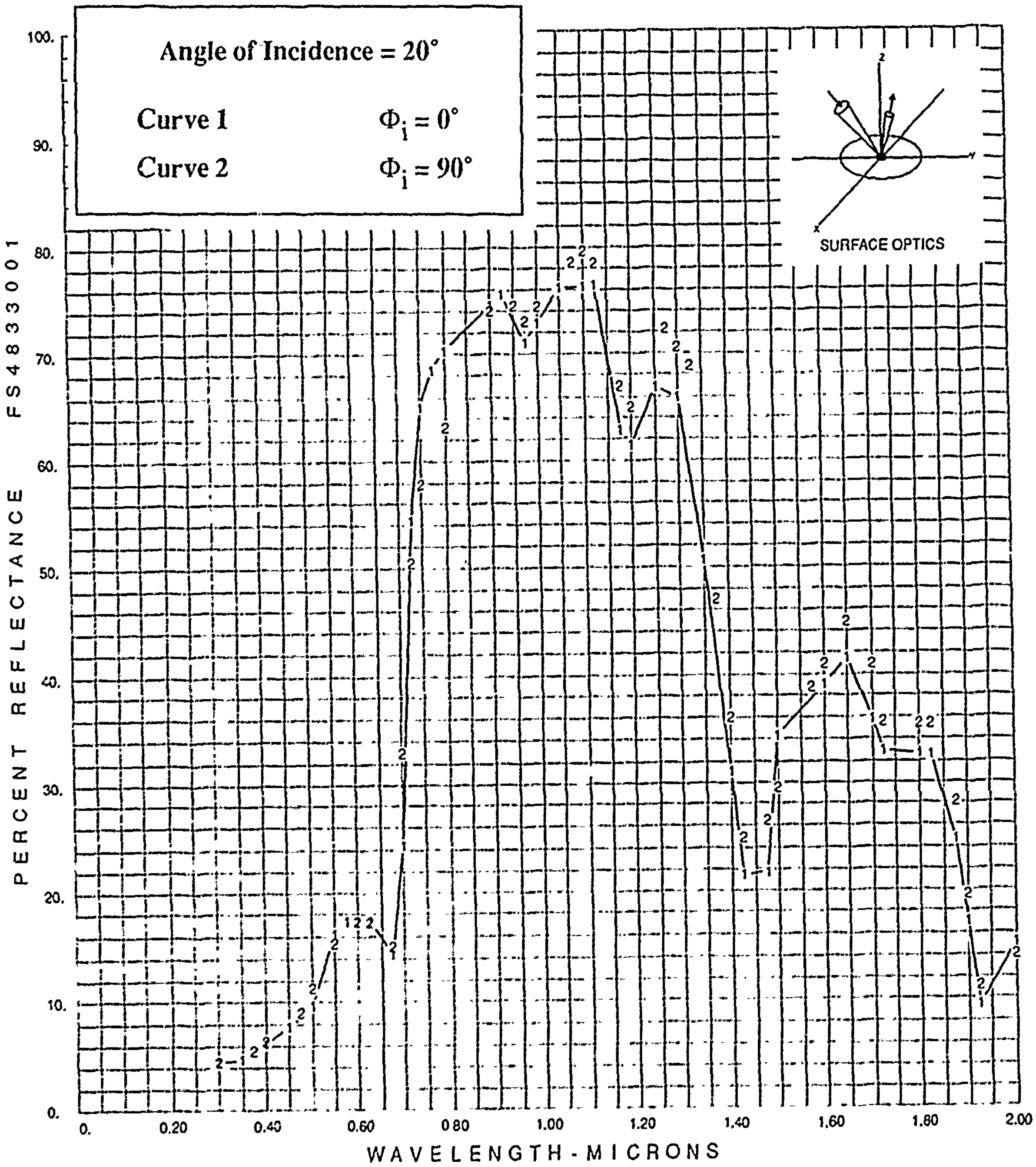

Figure 21. FS4833: Bark Sample #1
Directional Reflectance vs. Wavelength
ϕ_i = 0 and 90°
Bandwidth 0.3 to 2.0 μm

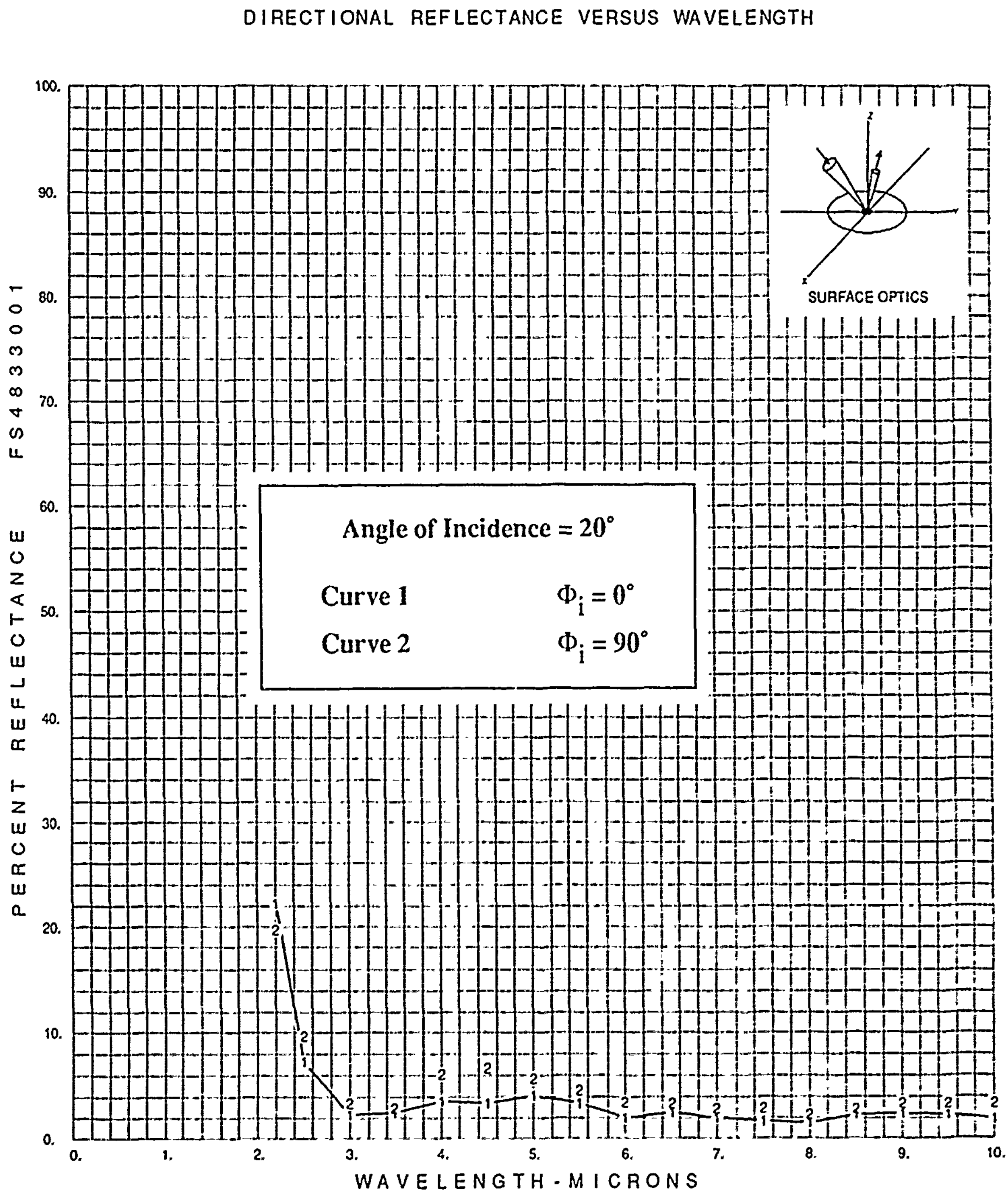

Figure 22. FS4833: Bark Sample #1
Directional Reflectance vs. Wavelength
$\phi_i = 0$ and 90°
Bandwidth 2.2 to 10.0 μm

DIRECTIONAL REFLECTANCE VERSUS WAVELENGTH

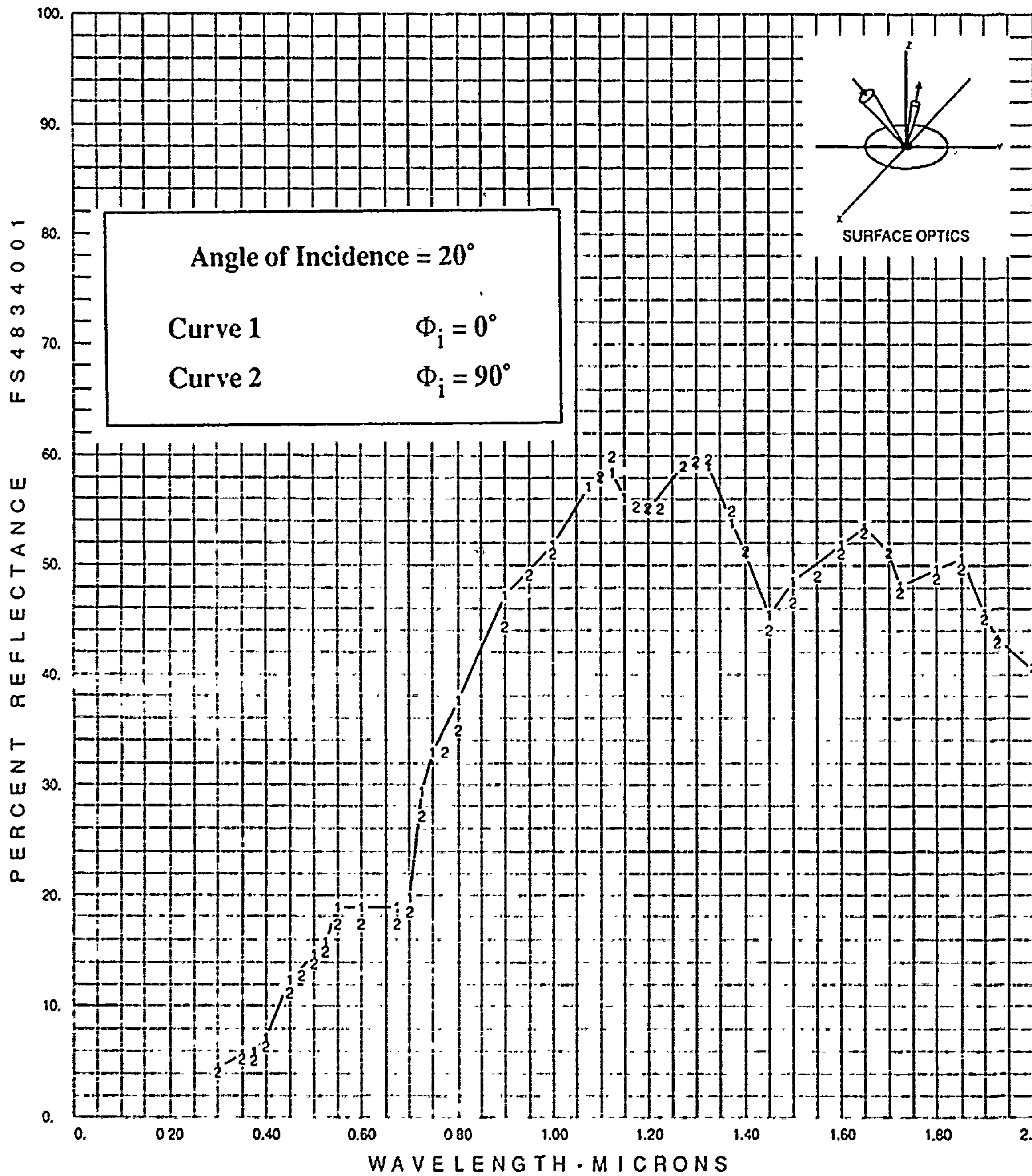

Figure 23. FS4834: Bark Sample #2
Directional Reflectance vs. Wavelength
ϕ_i = 0 and 90°
Bandwidth 0.3 to 2.0 µm

DIRECTIONAL REFLECTANCE VERSUS WAVELENGTH

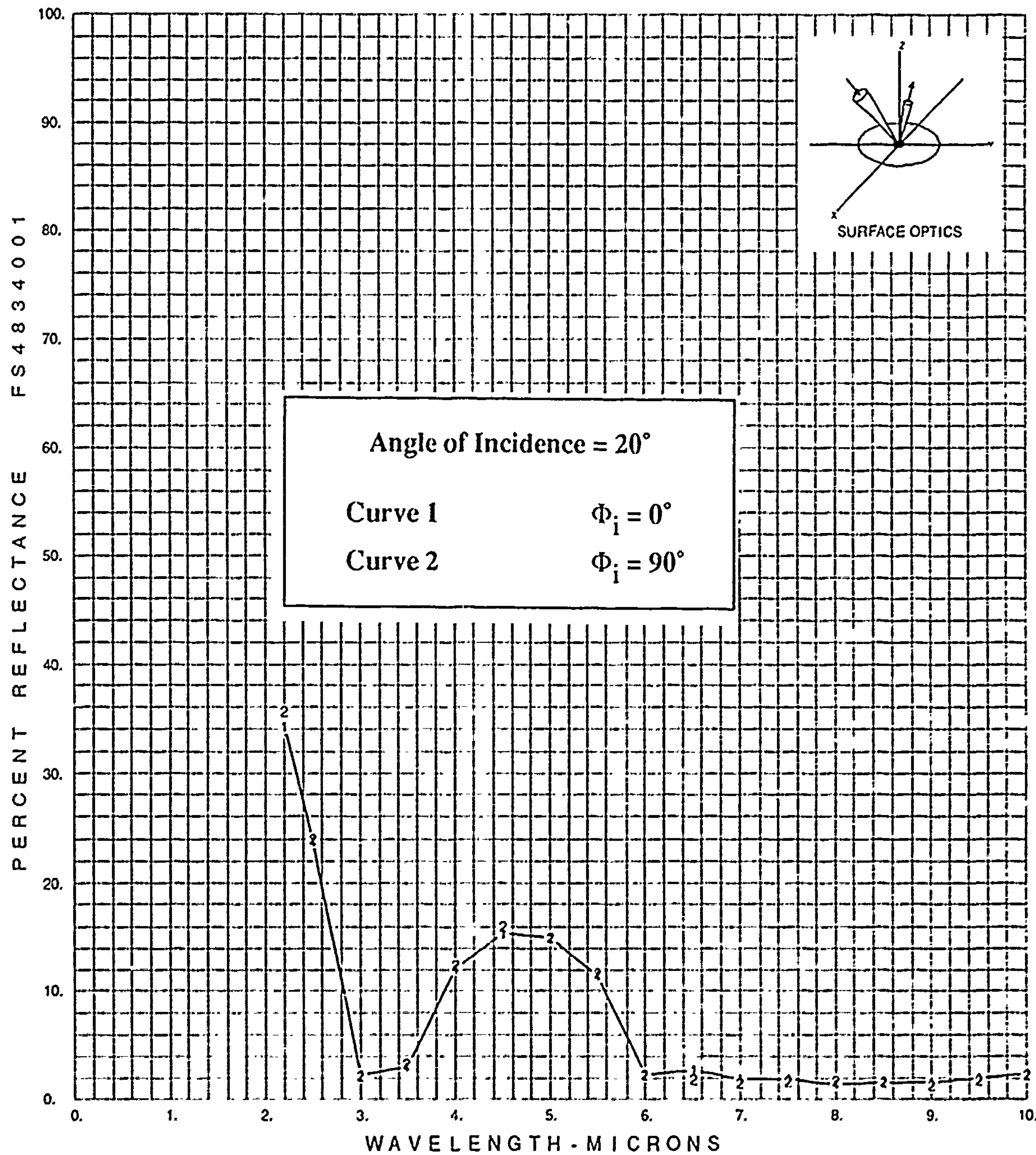

Figure 24. FS4834: Bark Sample #2
Directional Reflectance vs. Wavelength
ϕ_i = 0 and 90°
Bandwidth 2.2 to 10.0 μm

DIRECTIONAL REFLECTANCE VERSUS WAVELENGTH

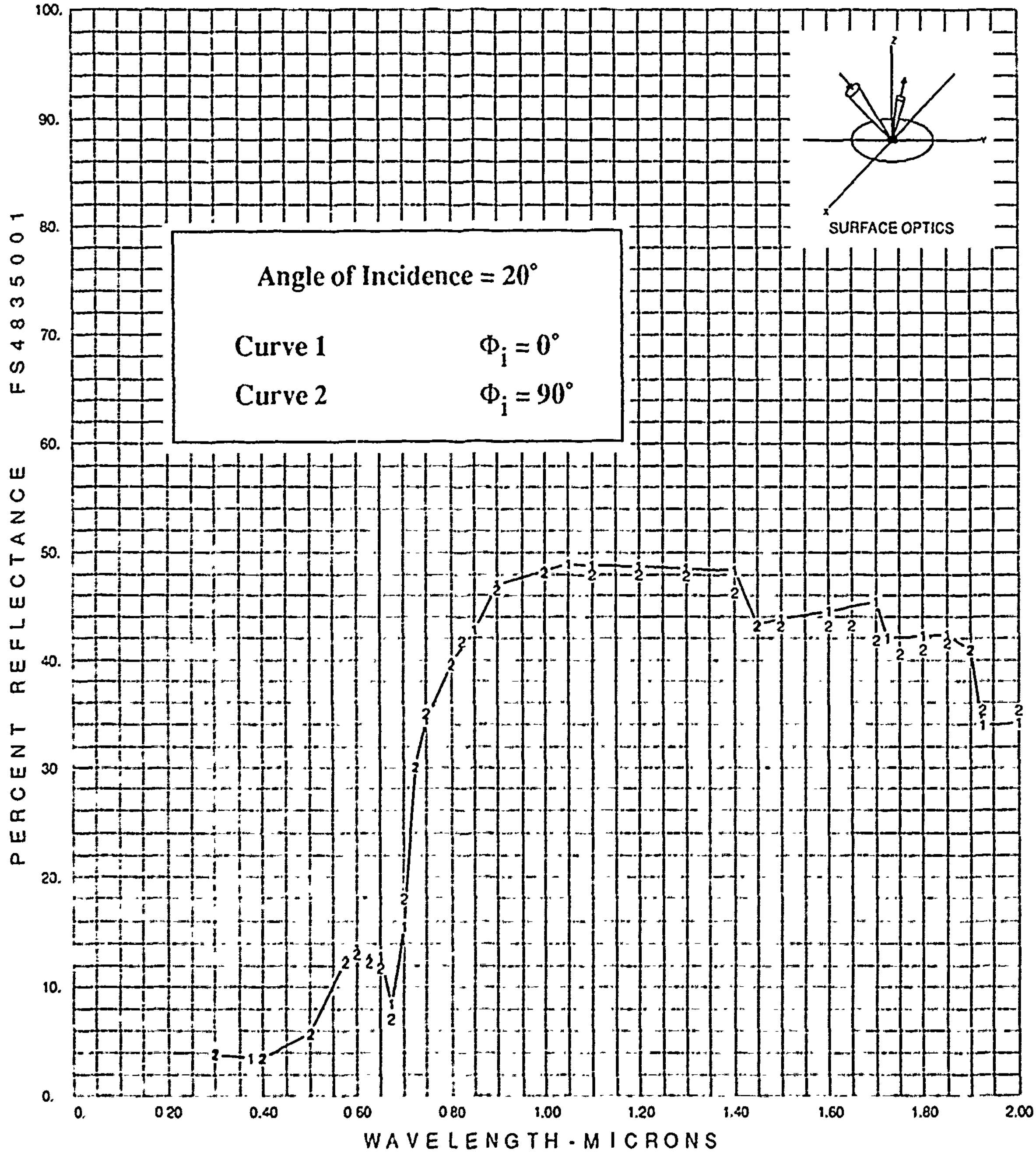

Figure 25. FS4835: Leaf Sample - Top Side
Directional Reflectance vs. Wavelength
$\phi_i = 0$ and 90°
Bandwidth 0.3 to 2.0 μm

DIRECTIONAL REFLECTANCE VERSUS WAVELENGTH

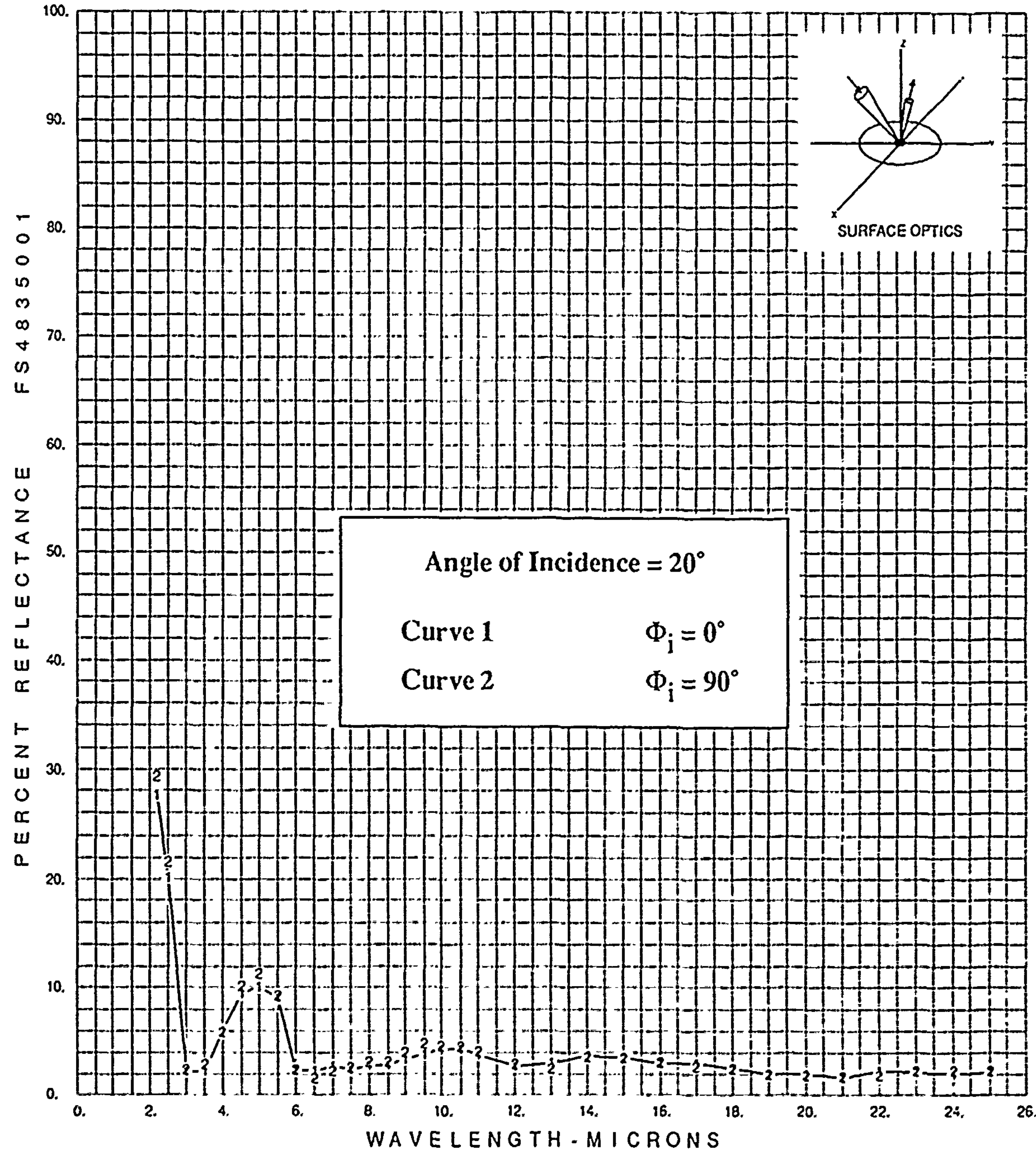

Figure 26. FS4835: Leaf Sample - Top Side
Directional Reflectance vs. Wavelength
ϕ_i = 0 and 90°
Bandwidth 2.2 to 25.0 μm

DIRECTIONAL REFLECTANCE VERSUS WAVELENGTH

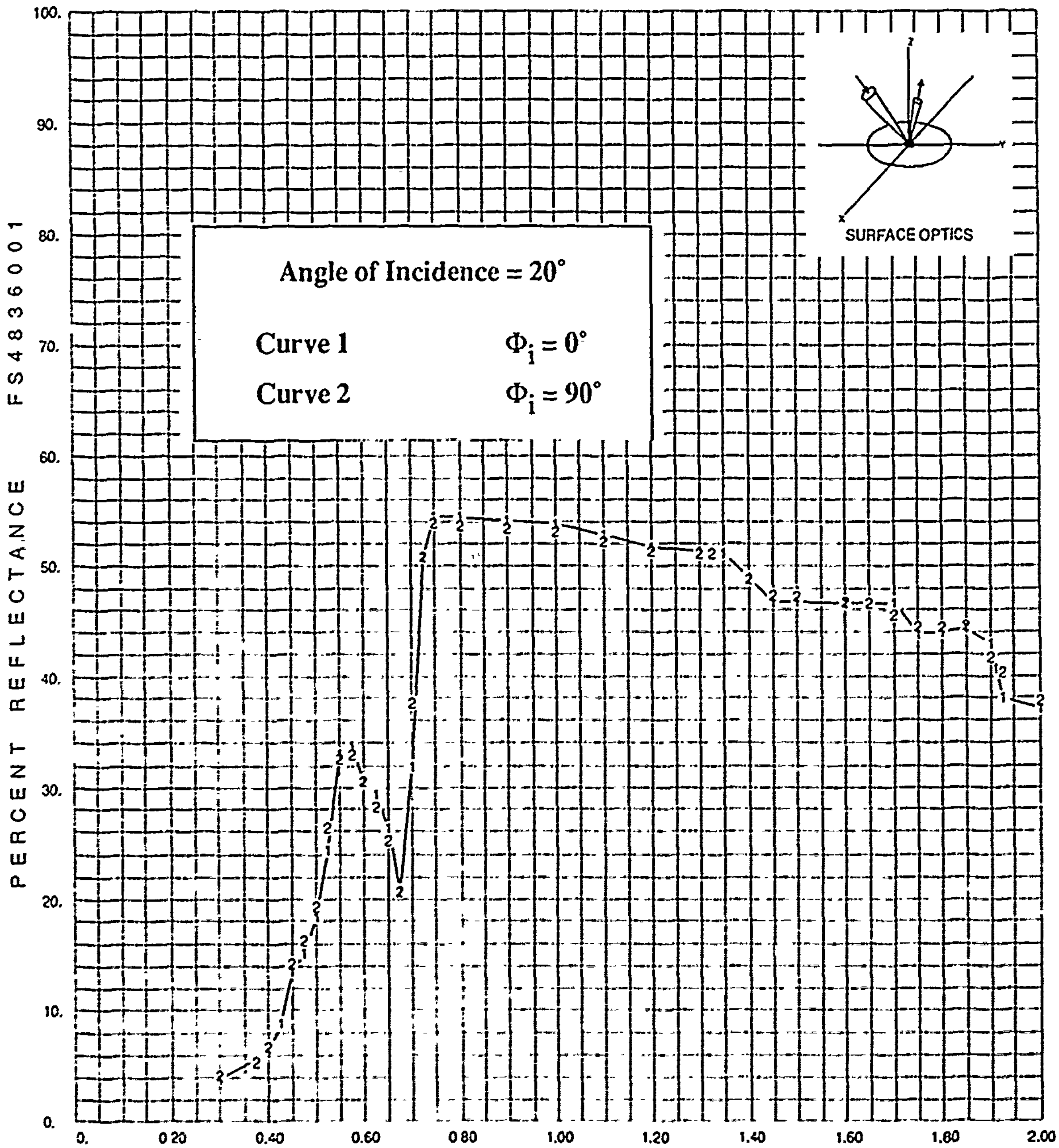

Figure 27. FS4836: Leaf Sample - Bottom Side
Directional Reflectance vs. Wavelength
ϕ_i = 0 and 90°
Bandwidth 0.3 to 2.0 μm

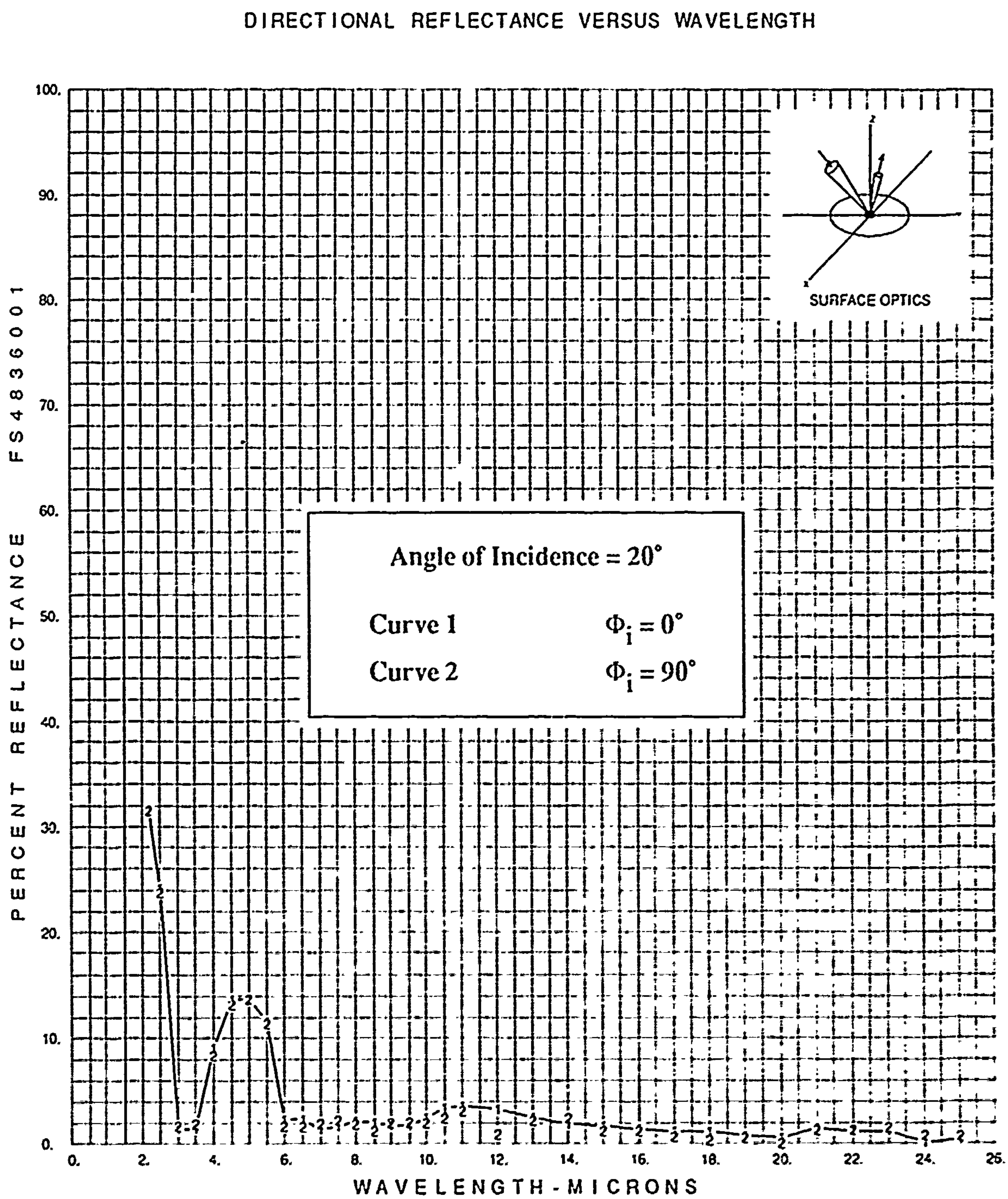

Figure 28. FS4836: Leaf Sample - Bottom Side
Directional Reflectance vs. Wavelength
ϕ_i = 0 and 90°
Bandwidth 2.2 to 25.0 μm

7.5 Angular Reflectance Problems of Leaves

The first phase of the measurement program involved making angular DR measurements. This meant that the samples, the leaf samples in particular, were exposed for extended periods of time to high temperature radiation sources (approximately two hours in each instrument). In the ellipsoidal reflectometer (measuring data from 1.6 to 25.0 μm) the combination of forced nitrogen cooling and a highly conductive copper mount allow the sample to remain in place for 2 to 3 hours without any noticeable loss of moisture and freshness. The Cary reflectometer (measuring data from 0.3 to 1.6 μm), however, does not have such an efficient cooling apparatus. Even with cool nitrogen blowing directly onto the sample surface, the proximity of the sample to the 55 watt quartz-halogen bulb in the Cary means that the sample starts to suffer a noticeable loss of moisture after about 15 minutes. In terms of the measurements, this means that the sample will stay fresh for only about two or three scans, where sixteen scans are necessary to complete the measurement in the spectral band from 0.3 to 1.6 μm.

In order to remain as consistent as possible, the angular DR data for the leaves was collected in both instruments using the same sample (i.e. one top leaf sample and one bottom leaf sample). This resulted in a mismatch at 1.6 μm in the data where the two instruments overlap. The resulting mismatch was greater for FS4835 (leaf - top side) where the data from the Cary reflectometer was measured after the data from the ellipsoidal reflectometer. Since the data from the ellipsoidal reflectometer was measured first for FS4835 the sample had not undergone severe moisture loss before measurement in the Cary where it did suffer from moisture loss. In fact the sample began to dry while measuring the DR in the Cary. The result was that reflectance was continuously changing during the measurement as the sample dried. Since this did not occur in the ellipsoidal reflectometer, the spectral region where the two instruments overlap show considerable disagreement for sample FS4835 (leaf - top side). Since the effect of drying the top side of the leaf causes greater changes in the reflectance in the near infrared spectral band (see Section 7.6), the resulting data at 1.6 μm from the Cary reflectometer for FS4835 (leaf - top side) is significantly higher than the reflectance at 1.6 μm from the ellipsoidal reflectometer. The loss of moisture introduced an uncertainty in the measurements (<u>for FS4835 only</u>) of upwards of 12% reflectance. The error is always positive so that the reported reflectance spectra is higher than the actual reflectance of a fresh leaf. This error is strongly wavelength dependent since the effects of drying the leaves on the reflectance is also wavelength dependent.

For sample FS4836 (leaf - bottom side) the data from the Cary was measured first. Then the sample, which had already suffered severe moisture loss, was measured in the ellipsoidal reflectometer where it essentially remained unchanged. Since changes due to the drying of the leaves are not as pronounced for the bottom side of the leaf as they are for the top side (see Section 7.6), the data at 1.6 μm from the ellipsoidal reflectometer matches more closely the data at 1.6 μm from the Cary for sample FS4836 (leaf - bottom side). Tables 6 and 7 show the reflectance from both instruments at 1.6 μm for FS4835 (leaf - top side) and FS4836 (leaf - bottom

side). The error introduced due to the drying of the bottom side of the leaf during the measurement cycle amounts to an uncertainty of only 5% at most for FS4836.

Table 6

FS4835: Leaf Sample - Top Side
Comparison of Directional Reflectance at 1.6 µm
for Cary Reflectometer and Ellipsoidal Reflectometer

ANGLE OF INCIDENCE	FS4835 PERCENT REFLECTANCE AT 1.6 MICROMETERS	
	CARY REFLECTOMETER	ELLIPSE REFLECTOMETER
20°	36.7	23.2
30°	39.0	24.8
40°	42.0	26.9
50°	44.3	29.3
60°	46.8	32.8
70°	50.3	37.9
75°	51.9	41.1
80°	54.1	44.5

Table 7

FS4836: Leaf Sample - Bottom Side
Comparison of Directional Reflectance at 1.6 µm
for Cary Reflectometer and Ellipsoidal Reflectometer

ANGLE OF INCIDENCE	FS4836 PERCENT REFLECTANCE AT 1.6 MICROMETERS	
	CARY REFLECTOMETER	ELLIPSE REFLECTOMETER
20°	37.9	40.7
30°	40.7	43.1
40°	49.4	45.0
50°	52.2	48.6
60°	53.9	52.1
70°	56.6	57.1
75°	57.8	59.9
80°	59.4	63.9

The bark samples did not exhibit such dramatic changes in reflectance as they dried as were observed in the leaves. The uncertainty in the measurements of the bark and all other measurements reported (other than FS4835 and FS4836) are the same as those reported earlier in the error analysis section of this report.

7.6 Fresh and Dry Leaf Measurements

Sixteen separate leaf samples (8 from the top of the leaf and 8 from the bottom) were prepared in Phase 2 for reflectance tests. The samples were cut from random positions on the leaves and oriented such that 0° incident azimuth was in the direction of the main vain (see Section 7.3). Directional reflectance (DR) was measured for all 16 samples from 0.3 to 26.0 µm at 20° incidence on 19 October 1990 when the leaves were fresh and again on the 22nd of October after the leaves had dried at room temperature for three days. The main conclusion drawn from these tests is that the top side of the leaves are subject to greater change in reflectance during the drying process than are the bottom side. In particular, the reflectance for the top side of the leaves (dry) resembles that of the bottom side (fresh or dry). When moist, the reflectance for the top side

of the leaf is fairly flat from 3.0 to 26.0 μm, averaging about 3.0%. After drying, the reflectance for the top side shows a rise starting at 3.5 μm and ending at 6.0 μm with a peak at 4.5 to 5.0 μm of about 8 to 10%. This peak is also observed on the bottom side of the leaf (fresh or dry).

In the wavelength range from 0.5 to 2.0 μm, the reflectance for the top side (dry) is about 8 to 12% greater than the reflectance for the top side (fresh). This higher reflectance in the visible and near infrared wavelength is also seen in the data from the bottom side (fresh or dry). Figures 29 through 36 are intended as a summary of the reflectance tests for the second phase of this study. For the reflectance results of an individual sample from Phase 2 see Appendices E through T.

In summary, the reflectance spectra for the top and bottom halves of the leaves are noticeably different in the visible and near infrared bands when the leaves are fresh. These differences vanish when the leaves dry with the top half of the leaf changing, becoming similar to the bottom half.

7.7 Transmittance (Leaves)

In addition to the reflectance tests in Phase 2, four more leaf samples were randomly selected for scattered transmittance tests from 0.3 to 26.0 μm at 0° incidence. These transmittance tests were conducted on 22 October 1990 after the reflectance tests were completed. Despite the fact that the leaves from which the transmittance samples were taken were refrigerated and kept wrapped in the moist towels they were shipped in, these leaves still showed visible signs of drying (i.e. they were more brittle than a fresh leaf). However, these leaves were not as dry as the leaf samples that had been left out at room temperature for three days. Figures 37 and 38 show the results of the transmittance tests for these four samples.

Due to the high depletion rate of the leaves in Phase 1 of the measurements, a full set of transmittance data for a fresh leaf could not be collected. However, transmittance data for a fresh leaf from 0.3 to 2.0 μm was collected and is shown in Figures C-23 (FS4835) and D-23 (FS4836) of the appendices.

Since the leaf samples transmit, Equation (4) in Section 4.2.1 needs to be expressed as

$$\varepsilon_d(\theta_i,\phi_i,\lambda) = 1 - \rho(\theta_i,\phi_i,\lambda) - \tau(\theta_i,\phi_i,\lambda) \quad , \tag{20}$$

where τ is the transmittance of the material. Because it is possible for SOC to only measure transmittance at 0° incidence, the evaluation of the above equation is limited to θ_i = 20° only, the transmittance at 0° being used to model that at 20°. For the purposes of calculating solar absorptance for FS4835 (leaf - top side) and FS4836 (leaf - bottom side) the transmittance data from 0.3 to 2.0 μm for the fresh leaf was sufficient since the solar irradiance function, $J(\lambda)$, drops off quickly after 2.0 μm (see Section 4.2.2, Equation (10)).

DIRECTIONAL REFLECTANCE VERSUS WAVELENGTH

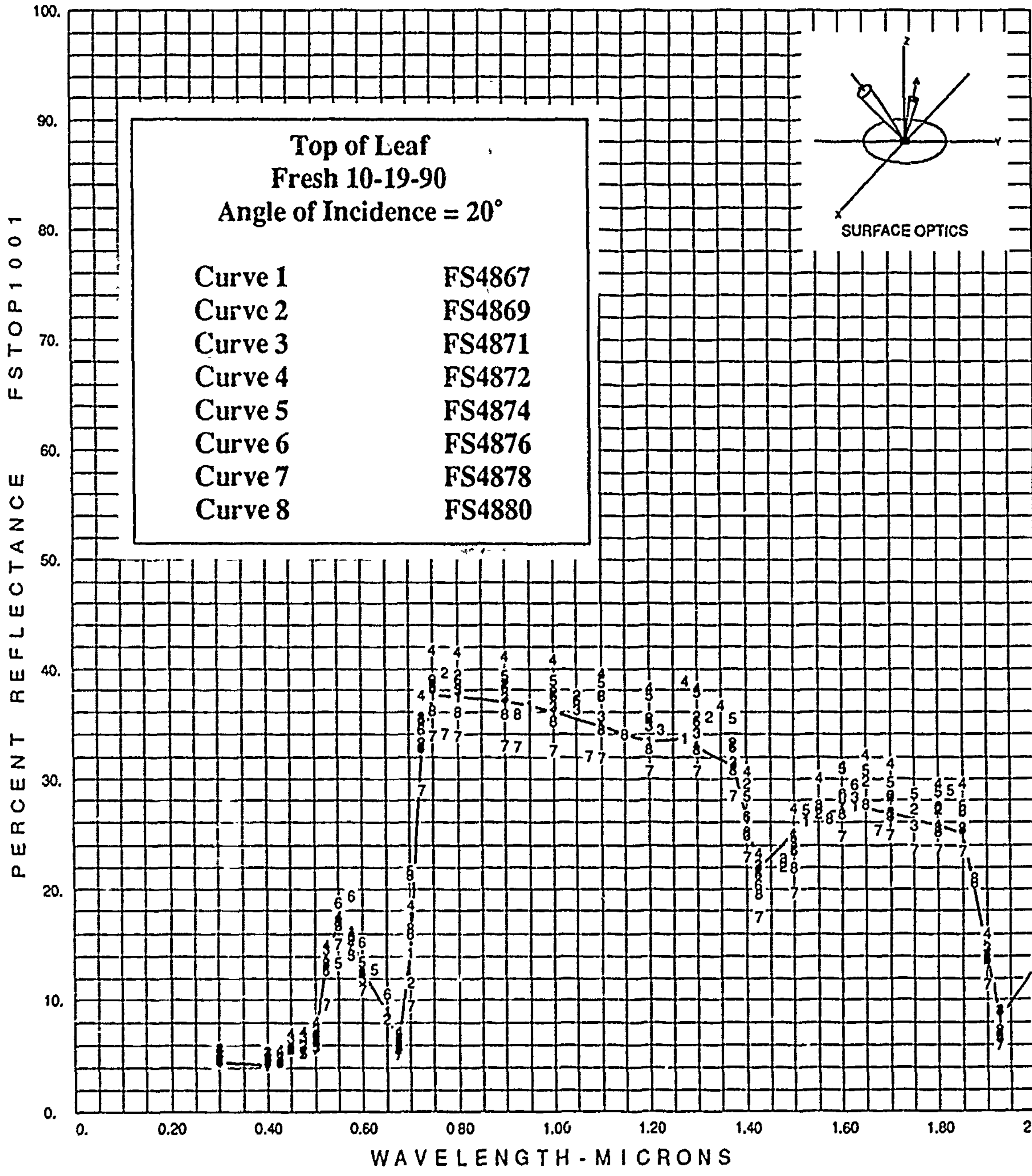

Figure 29. Comparison of Directional Reflectance for Eight Leaf Samples (Top, Fresh) Bandwidth 0.3 to 2.0 µm

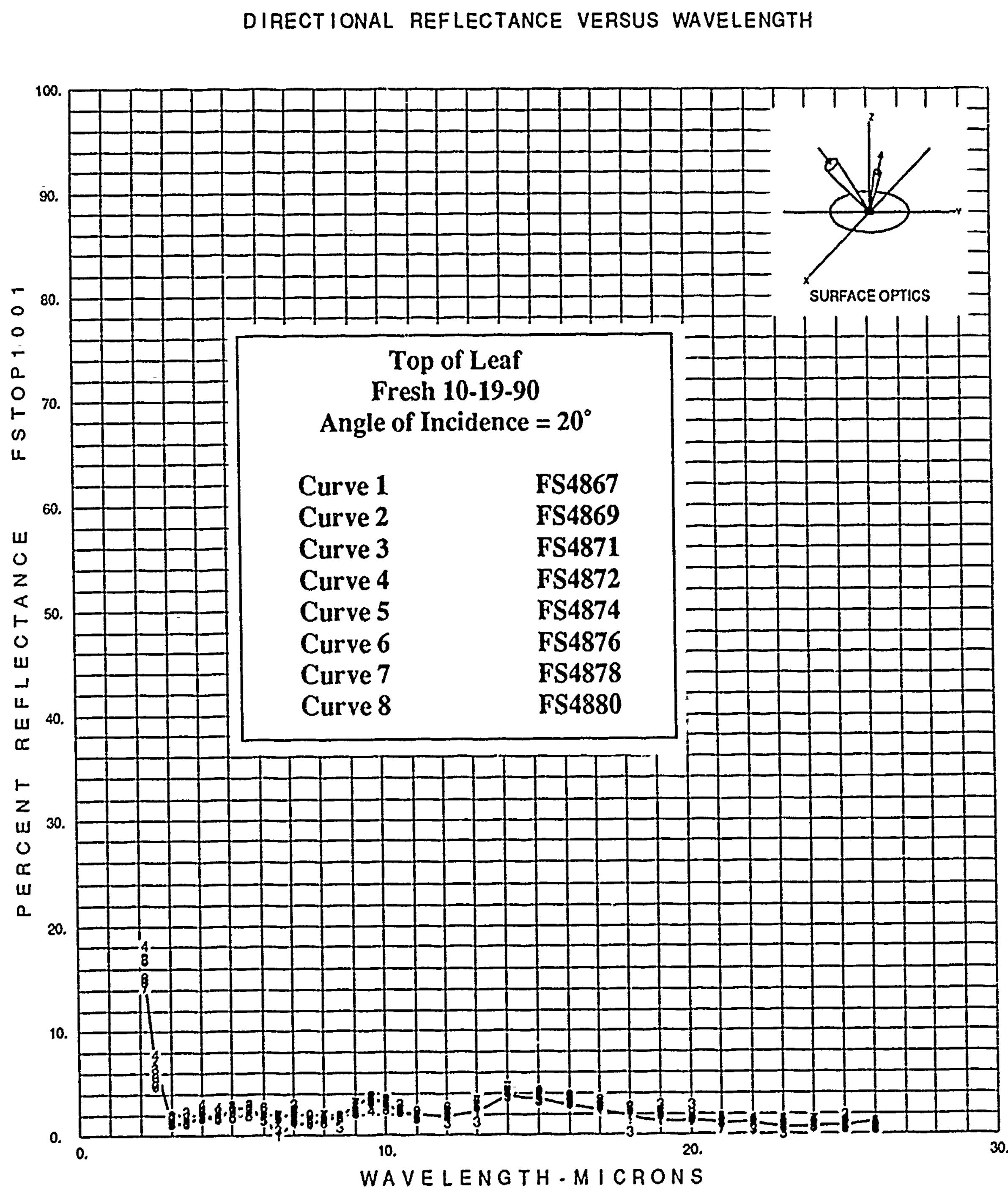

Figure 30. Comparison of Directional Reflectance for Eight Leaf Samples (Top, Fresh) Bandwidth 2.2 to 26.0 μm

DIRECTIONAL REFLECTANCE VERSUS WAVELENGTH

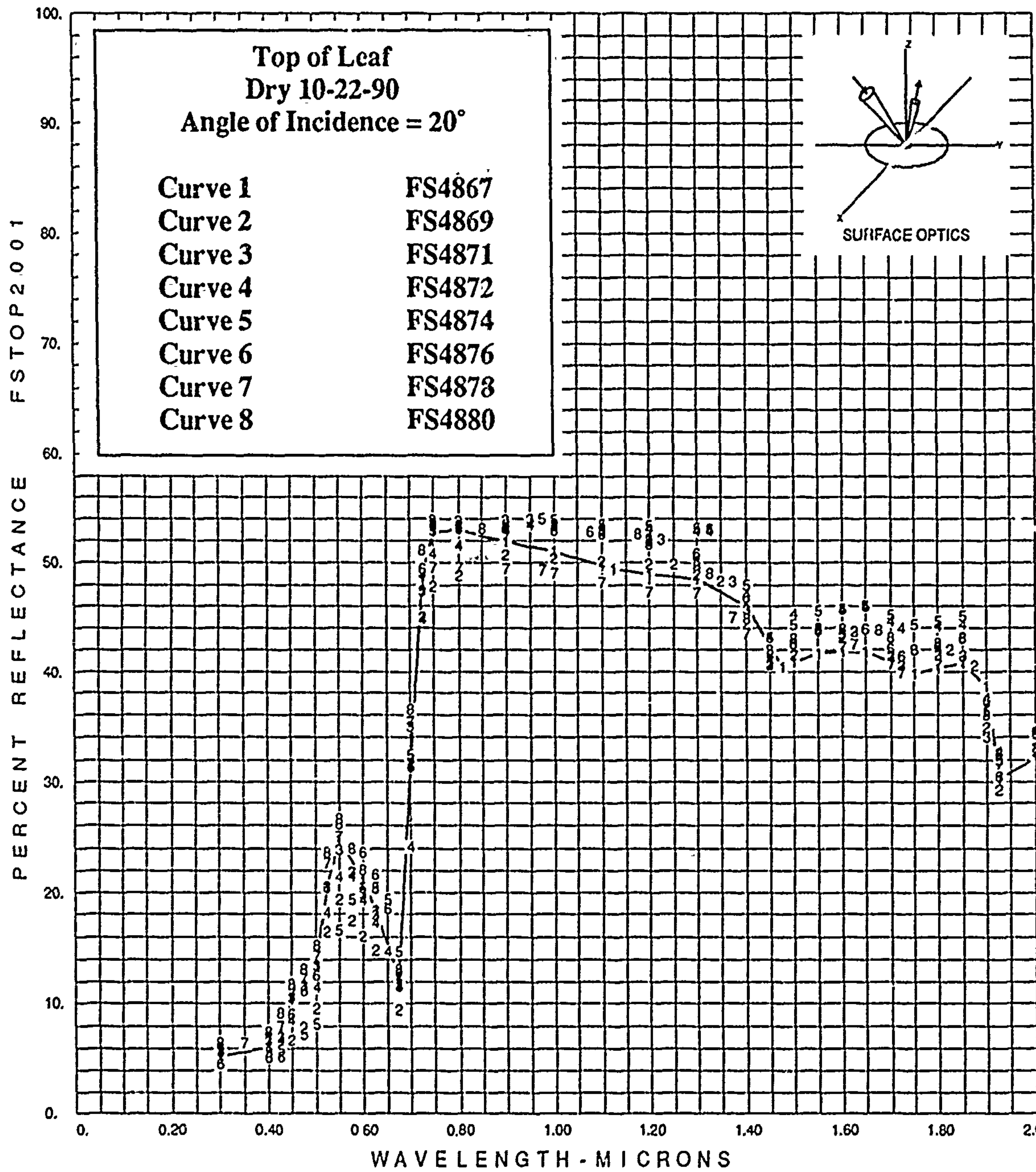

Figure 31. Comparison of Directional Reflectance for Eight Leaf Samples (Top, Dry) Bandwidth 0.3 to 2.0 μm

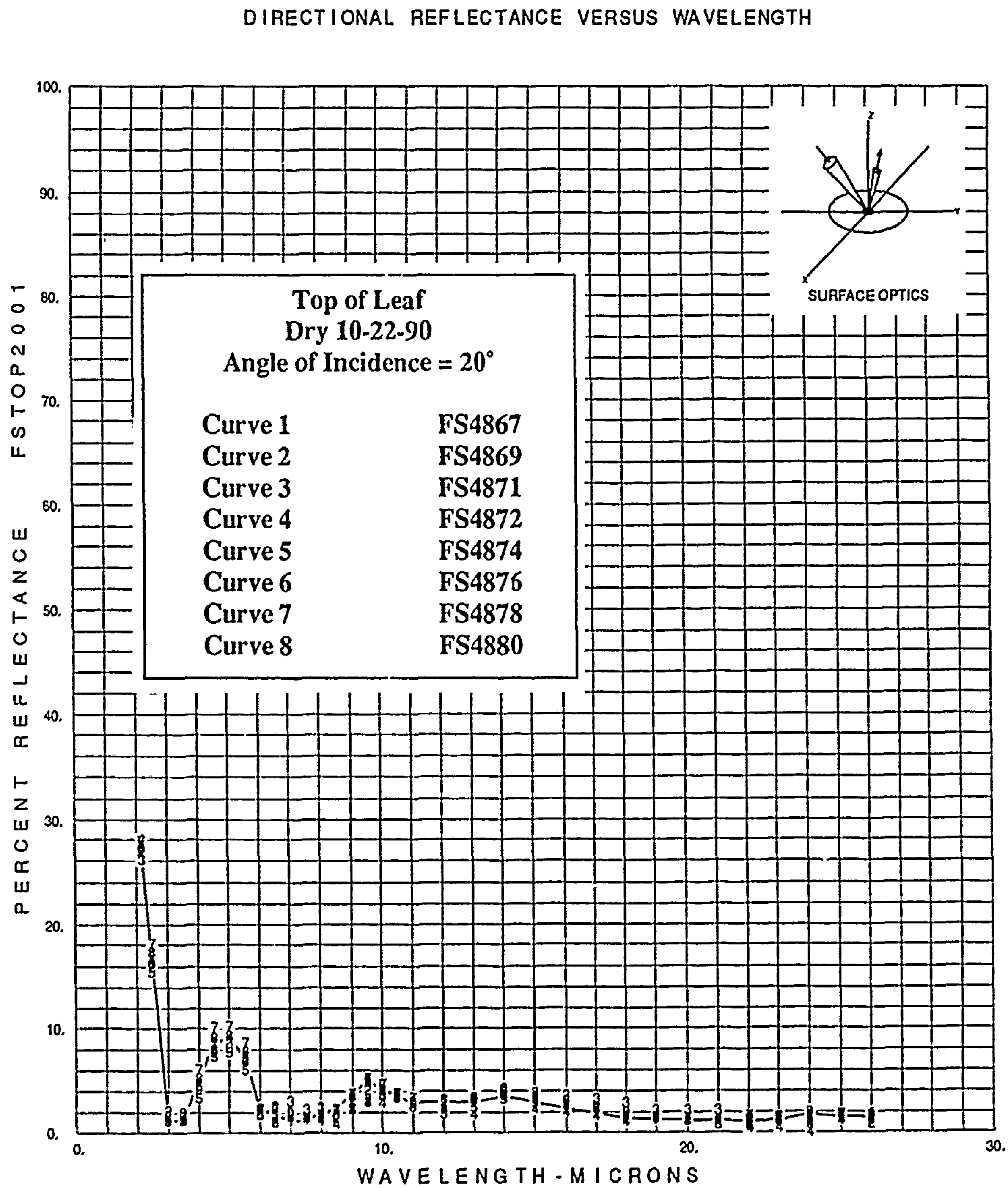

Figure 32. Comparison of Directional Reflectance for Eight Leaf Samples (Top, Dry) Bandwidth 2.2 to 26.0 μm

DIRECTIONAL REFLECTANCE VERSUS WAVELENGTH

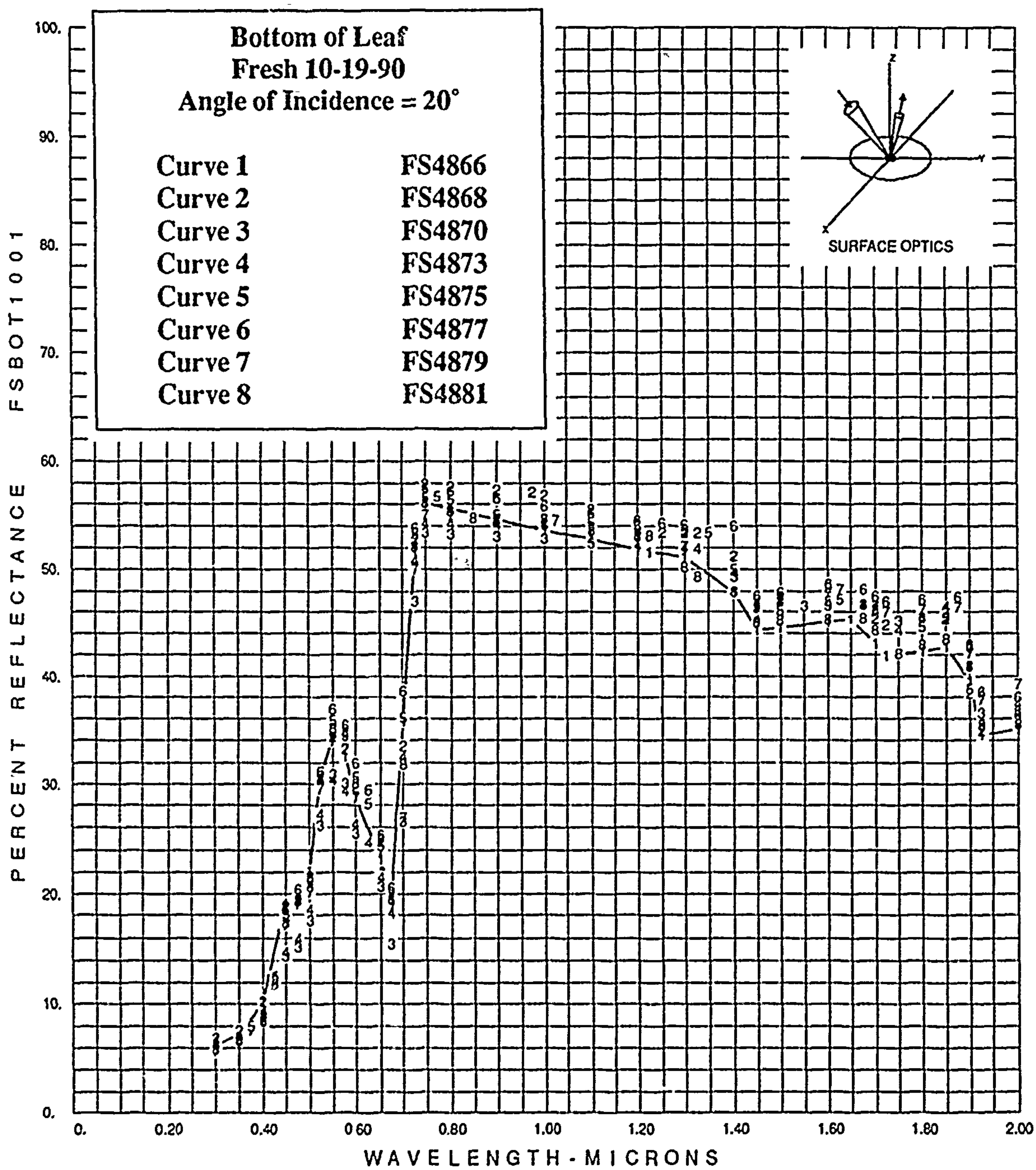

Figure 33. Comparison of Directional Reflectance for Eight Leaf Samples (Bottom, Fresh) Bandwidth 0.3 to 2.0 μm

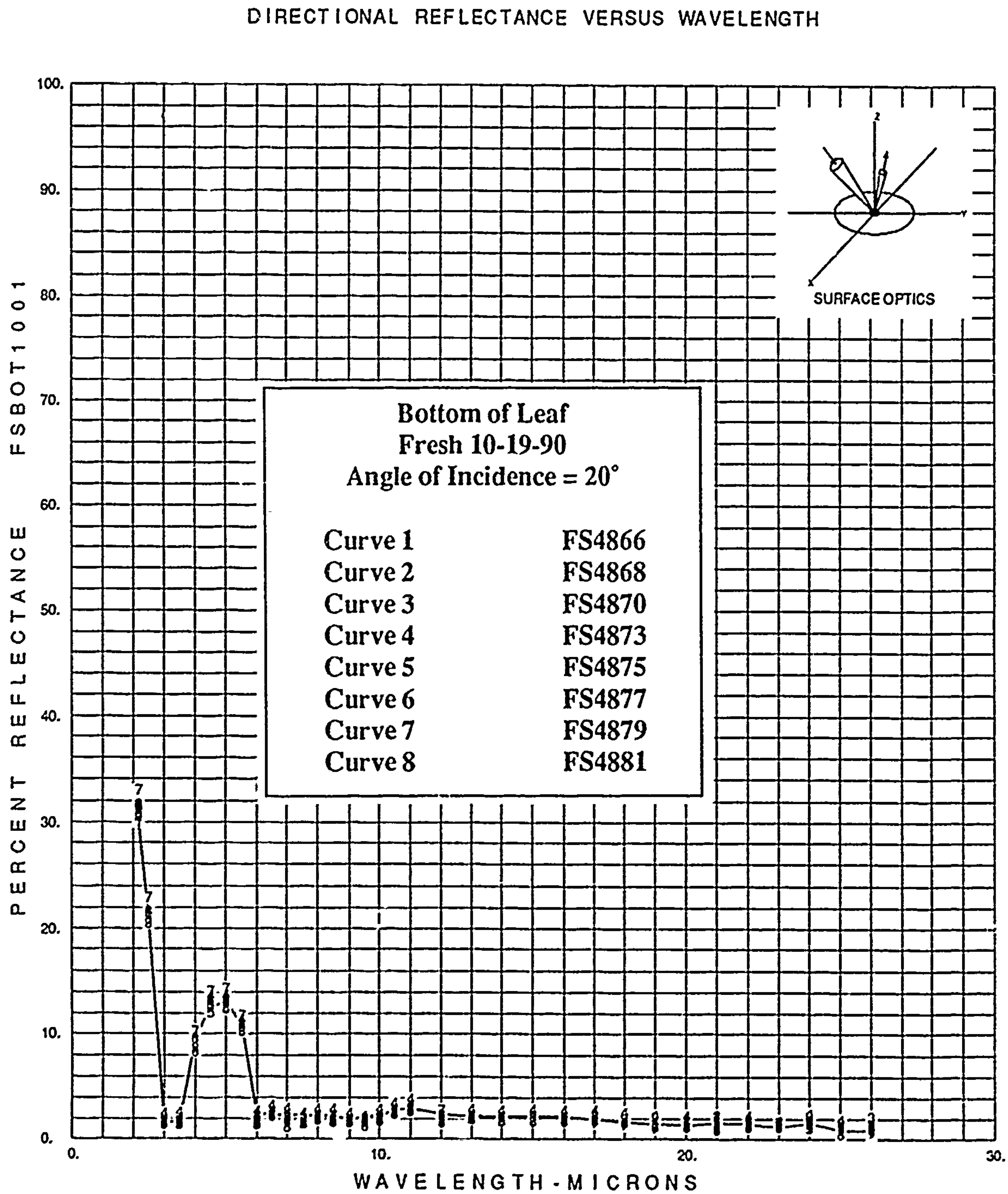

Figure 34. Comparison of Directional Reflectance for Eight Leaf Samples (Bottom, Fresh) Bandwidth 2.2 to 26.0 μm

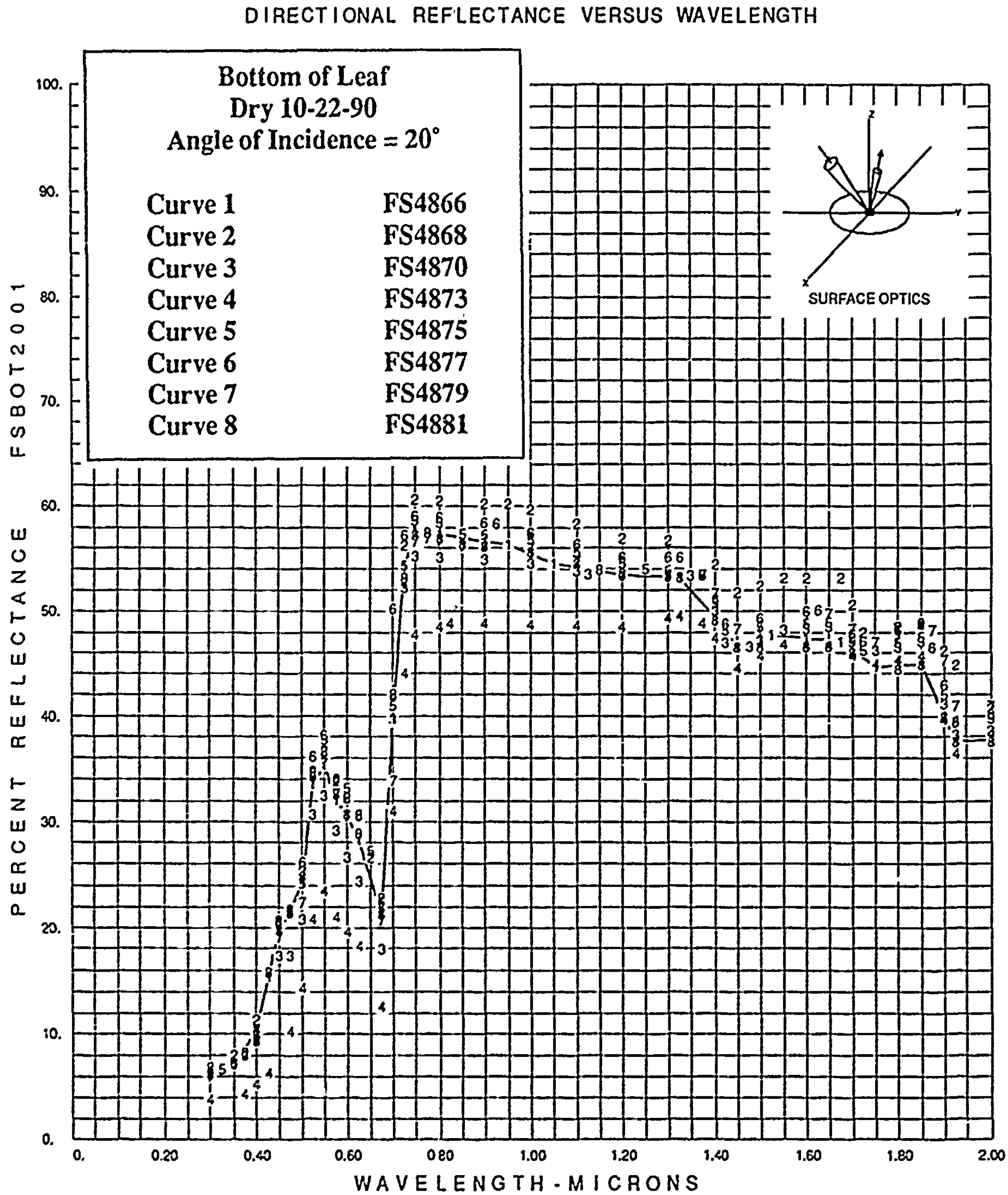

Figure 35. Comparison of Directional Reflectance for Eight Leaf Samples (Bottom, Dry) Bandwidth 0.3 to 2.0 μm

DIRECTIONAL REFLECTANCE VERSUS WAVELENGTH

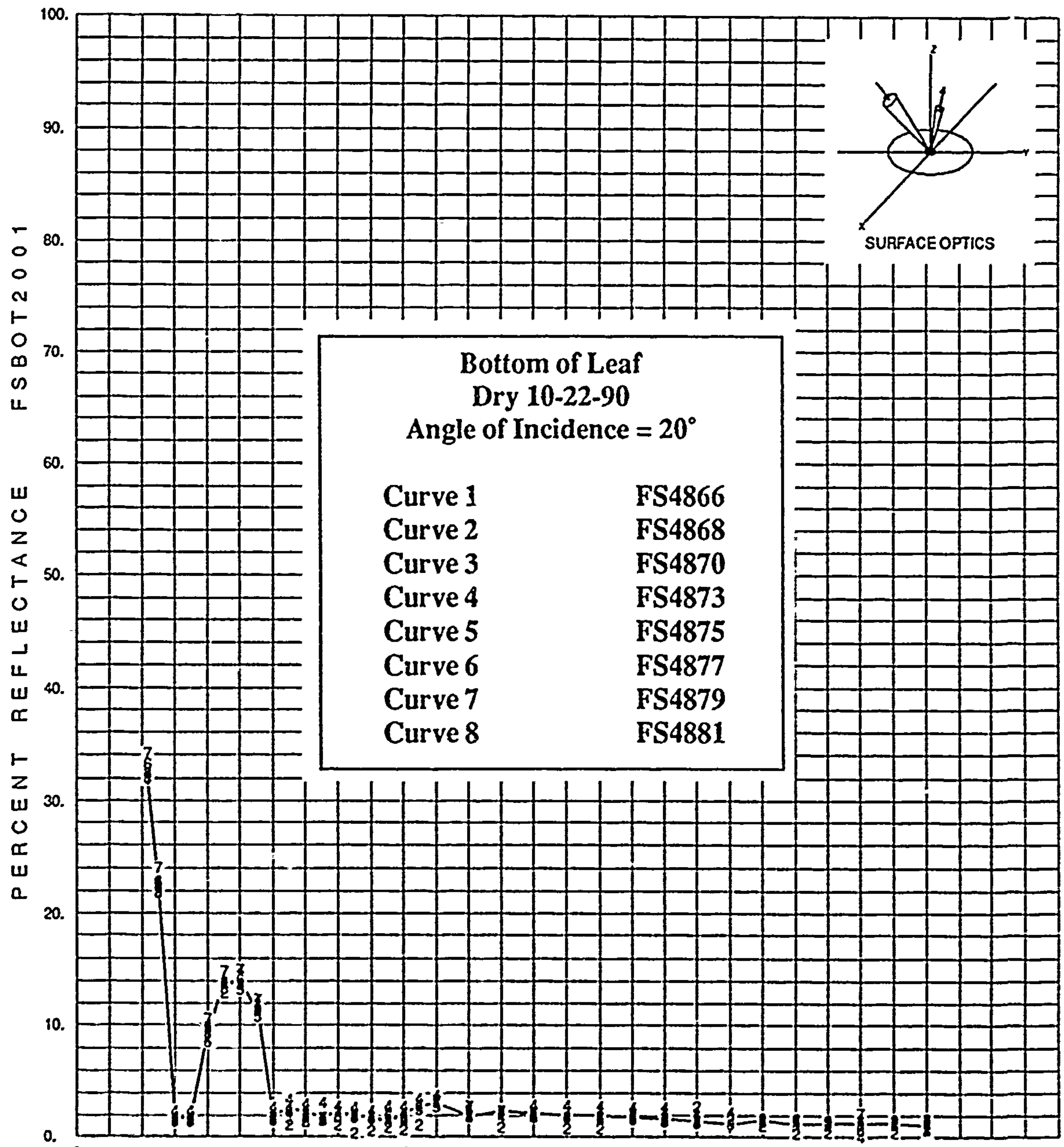

Figure 36. Comparison of Directional Reflectance for Eight Leaf Samples (Bottom, Dry) Bandwidth 2.2 to 26.0 μm

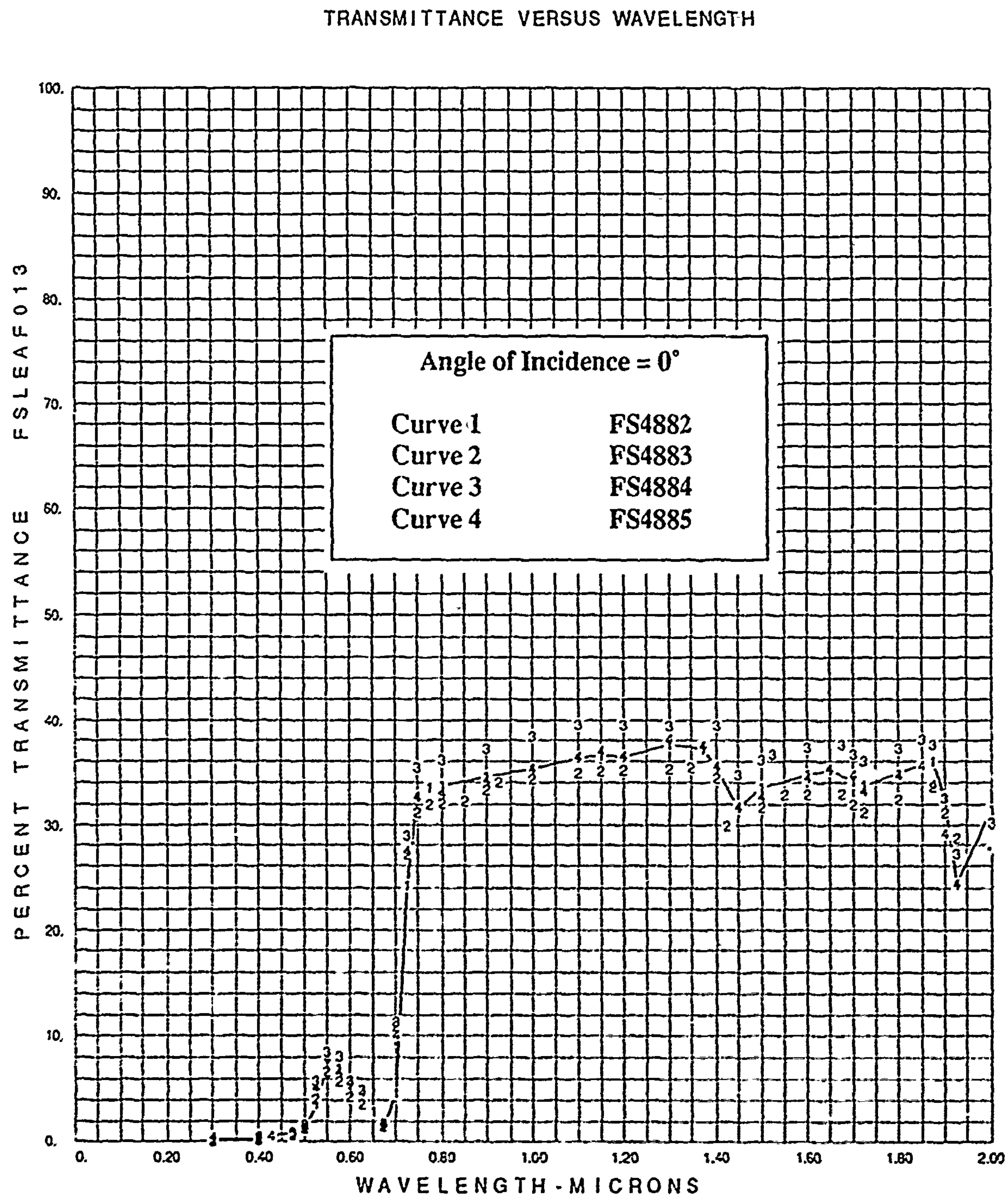

Figure 37. Comparison of Scattered Transmittance for Four Leaf Samples Bandwidth 0.3 to 2.0 μm

TRANSMITTANCE VERSUS WAVELENGTH

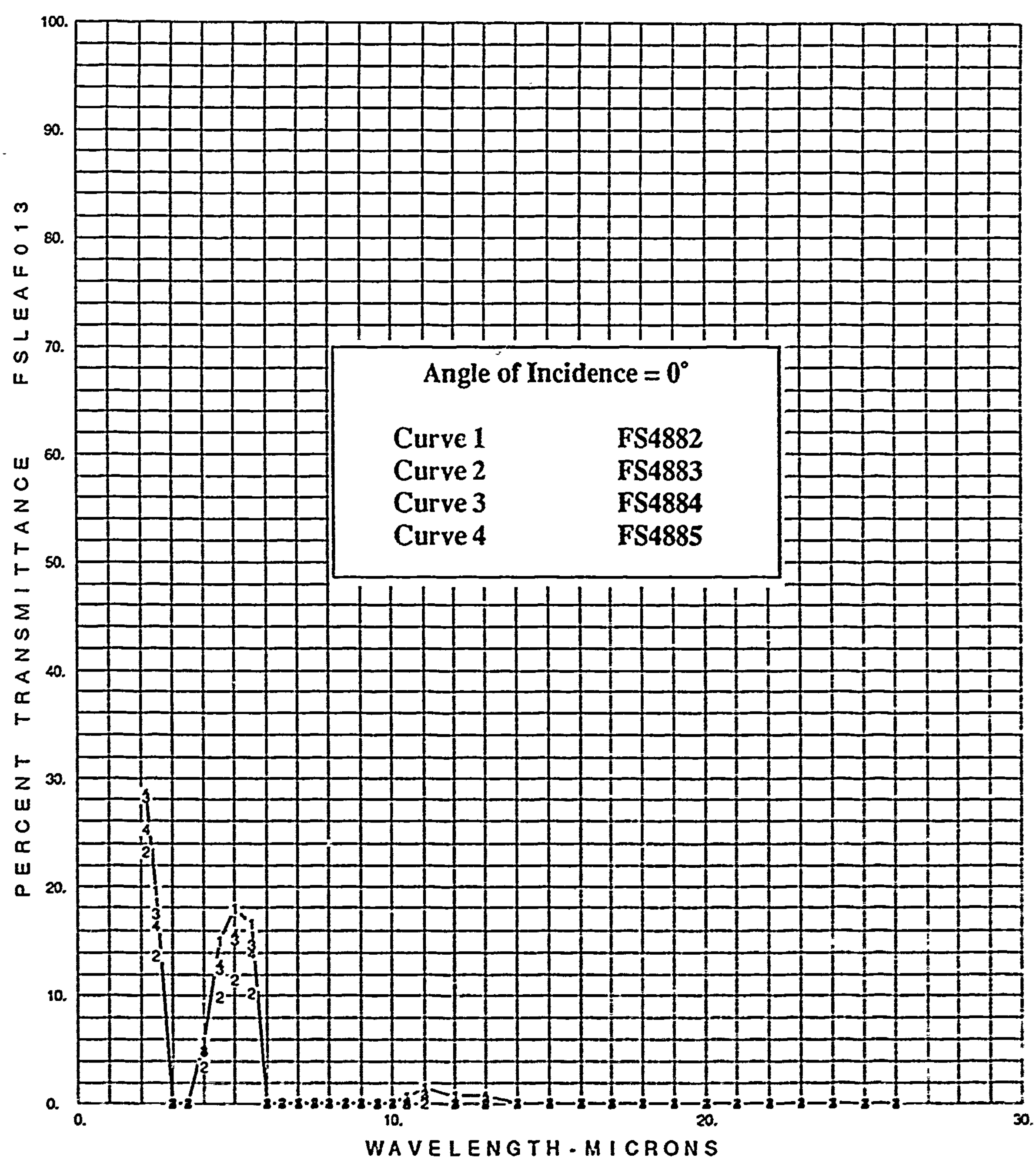

Figure 38. Comparison of Scattered Transmittance for Four Leaf Samples Bandwidth 2.2 to 26.0 μm

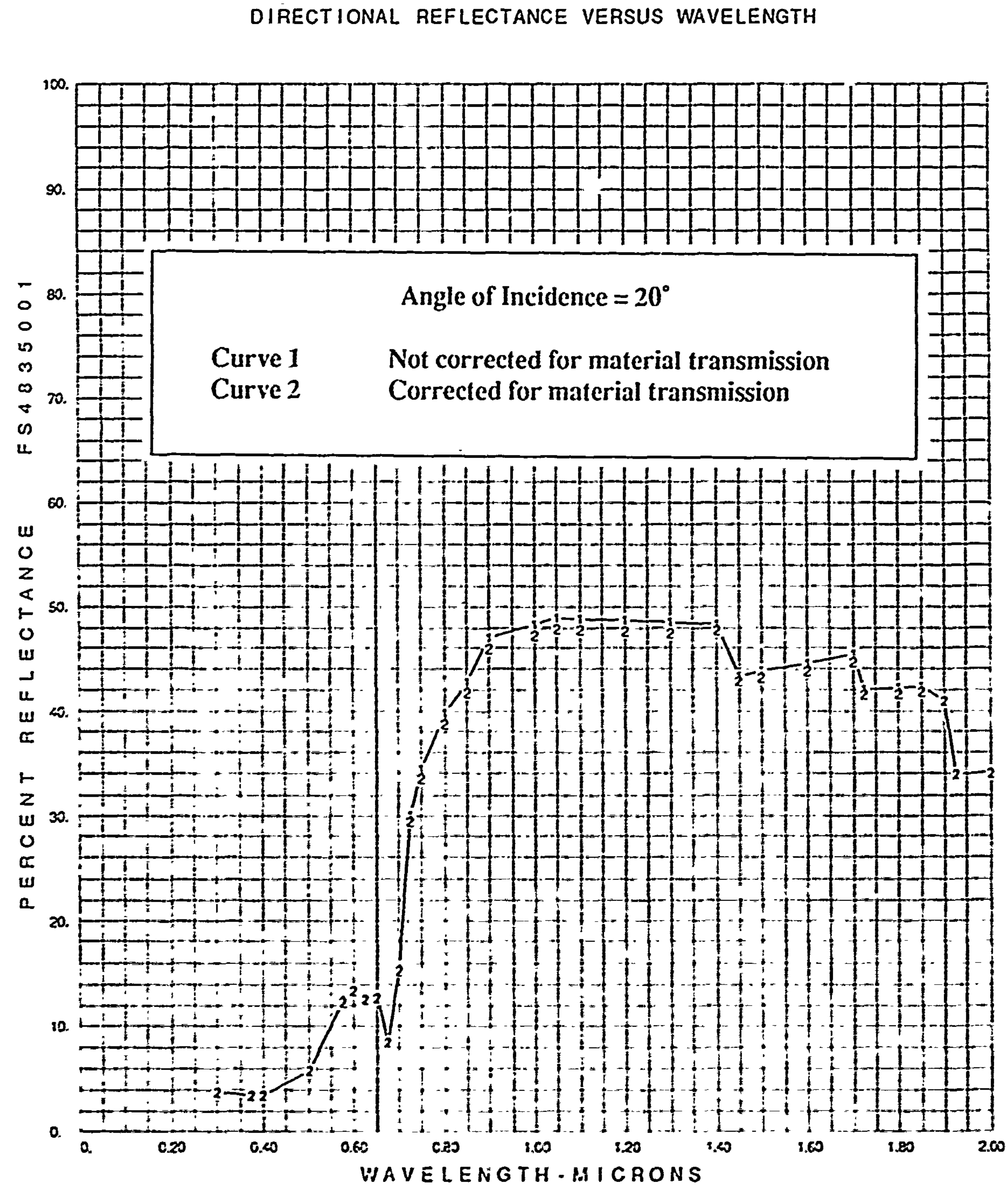

Figure 39. FS4835: Leaf Sample - Top Side
Comparison of Observed Reflectance (Curve 1)
to True Reflectance (Curve 2)
Bandwidth 0.3 to 2.0 µm

For the thermal emittance calculation, a model was needed to simulate the transmittance of a fresh leaf from 2.5 to 25.0 μm. In particular, transmittance data around 10.0 μm was needed to correctly calculate the thermal emittance at 300°K, since this is close to where Planck's Function, P(λ,T), peaks for 300°K (see Section 4.2.1, Equation (5)). Since the transmittance for the four leaves measured in Phase 2 is very close to 0% at and around 10.0 μm, and these four leaf samples were not completely dry, the data from 2.5 to 25.0 μm for FS4882 was combined with the transmission data from 0.3 to 2.0 μm for a fresh leaf (FS4835 and FS4836) for purposes of calculating emittance. This data is presented in Appendix U and also in Figures C-24 and D-24. The value of thermal emittance at 300°K using the above transmittance model is *0.968* while the same value using just the transmittance data from 0.3 to 2.0 μm from FS4835, and assuming the transmittance from 2.5 to 25.0 μm is 0%, is *0.975*. The error due to approximating the transmittance in the spectral band from 2.0 to 25.0 μm is on the order of 1%.

In addition to affecting the calculation of emittance and solar absorptance data, the transmittance also influences the directional reflectance of a sample. This occurs when an incident beam is partially transmitted through the sample material and strikes the substrate. Some of this energy is then reflected off the substrate and transmitted back through the sample surface thus contributing to the overall reflectance of the material. For all reflectance tests in both phases of this study, a low reflectance substrate was used to back the leaf samples (see Section 7.2). Figure 39 illustrates the difference between the observed reflectance, which includes the reflectance of the material in addition to any transmitted energy that reflects off the substrate and is transmitted back through the sample, and the true reflectance after subtracting the contribution from the substrate for FS4835 (leaf - top side) from 0.3 to 2.0 μm. Essentially, the error between the observed reflectance and the true reflectance can be approximated by $\Delta\rho_b \cong \tau^2\rho_b$, where ρ_b is the reflectance of the substrate ($\rho_b \cong 3.0\%$). The maximum transmittance for FS4835 is 51.0% at 1.1 μm, therefore the maximum error is approximately $\Delta\rho_b \cong (0.51)^2 \times (0.03) = 0.0078$ or 0.78%. Since this error is small, all reflectance data reported in the appendices is the observed reflectance.

7.8 Bidirectional Reflectance

In Phase 1 bidirectional reflectance (BDR) was measured for the two bark and two leaf (top and bottom) samples at 1.307, 4.601 and 10.0 μm at incident angles of 20, 40 and 60°. All samples were very diffuse at 1.307 μm, therefore the approximation $\rho_d \cong \pi\rho'$, where ρ' is the average BDR at that wavelength and incident angle, is fairly accurate. At the other wavelengths the samples were diffuse but using the above approximation is not as good because the out-of-plane BDR is much lower than the in-plane BDR.

It should also be noted that the BDR results for FS4835 (leaf - top side) were measured using a fresh leaf and since measuring BDR does not cause the leaf to dry out, the sample stayed fresh throughout the entire measurement. In Section 7.6 it was shown that a peak in the DR

occurs at about 4.5 to 5.0 μm when the top side of a leaf dries out, therefore it can be expected that the BDR at 4.6 μm for the top side of a leaf (dry) will be higher than when the top side of the leaf is fresh. The extent of this difference will depend on the magnitude of the change in the DR when the leaf dries. An increase of 4 to 5 times in the bidirectional reflectance in certain bands would not be unexpected given the data presented in the appendices.

APPENDIX A

SPECTRAL SCIENCES INC.
BARK SAMPLE #1, 2 PM,
WEST SIDE, 55 INCHES UP.
FS4833:

INDEX TO APPENDIX A

PAGE NO.

DIRECTIONAL REFLECTANCE

INDEX TO APPENDIX A (continued)

PAGE NO.

DIRECTIONAL REFLECTANCE

BIDIRECTIONAL REFLECTANCE

INDEX TO APPENDIX A (continued)

PAGE NO.

BIDIRECTIONAL REFLECTANCE

INDEX TO APPENDIX A (continued)

PAGE NO.

BIDIRECTIONAL REFLECTANCE

APPENDIX A

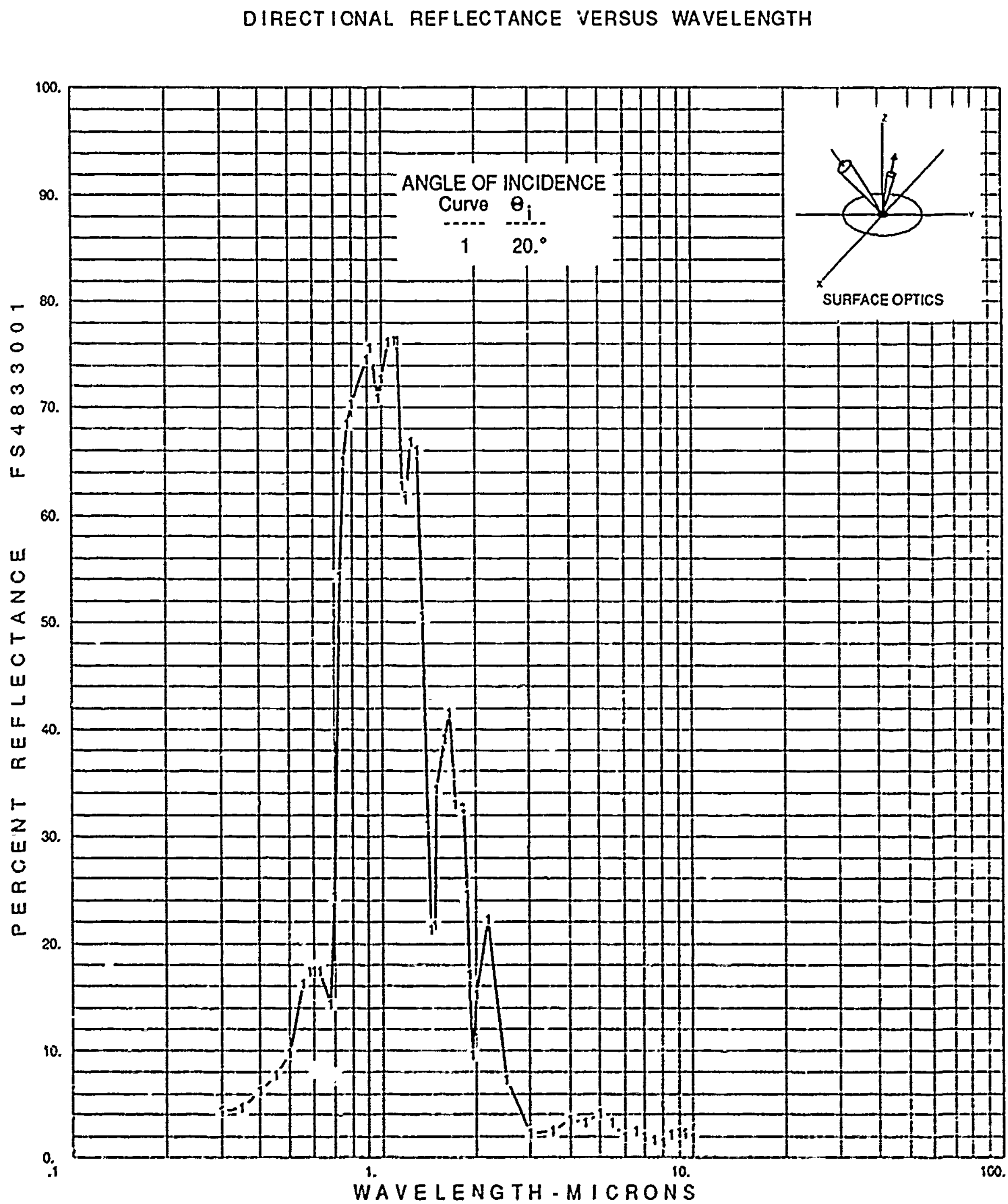

FIGURE A-1. SPECTRAL SCIENCES: BARK SAMPLE #1, 2PM, WEST SIDE, 55" UP. DIRECTIONAL REFLECTANCE VS. WAVELENGTH BANDWIDTH 0.3 TO 10.0 MICROMETERS DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX A

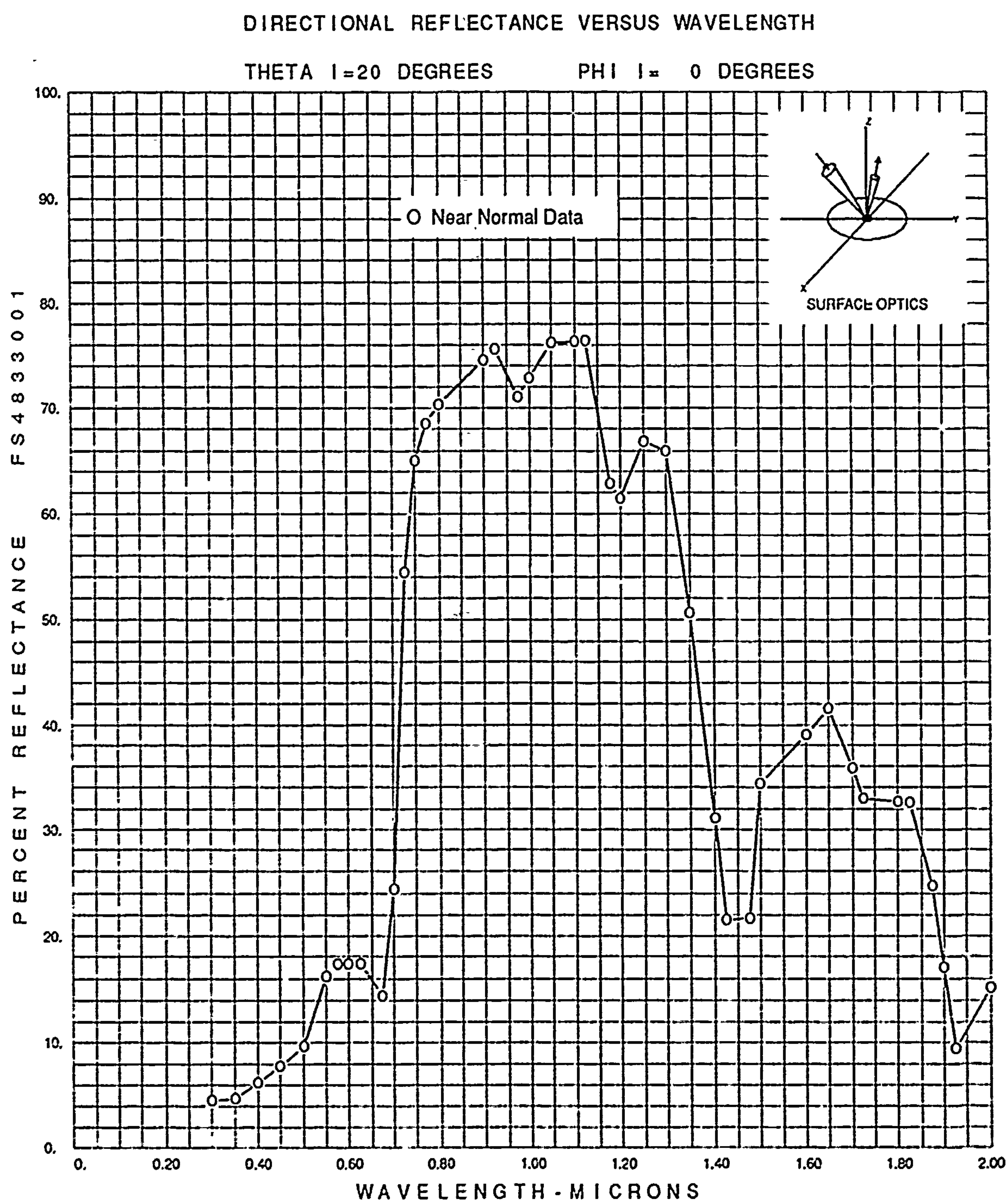

FIGURE A-2. SPECTRAL SCIENCES: BARK SAMPLE #1,
2PM, WEST SIDE, 55" UP.
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 2.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX A

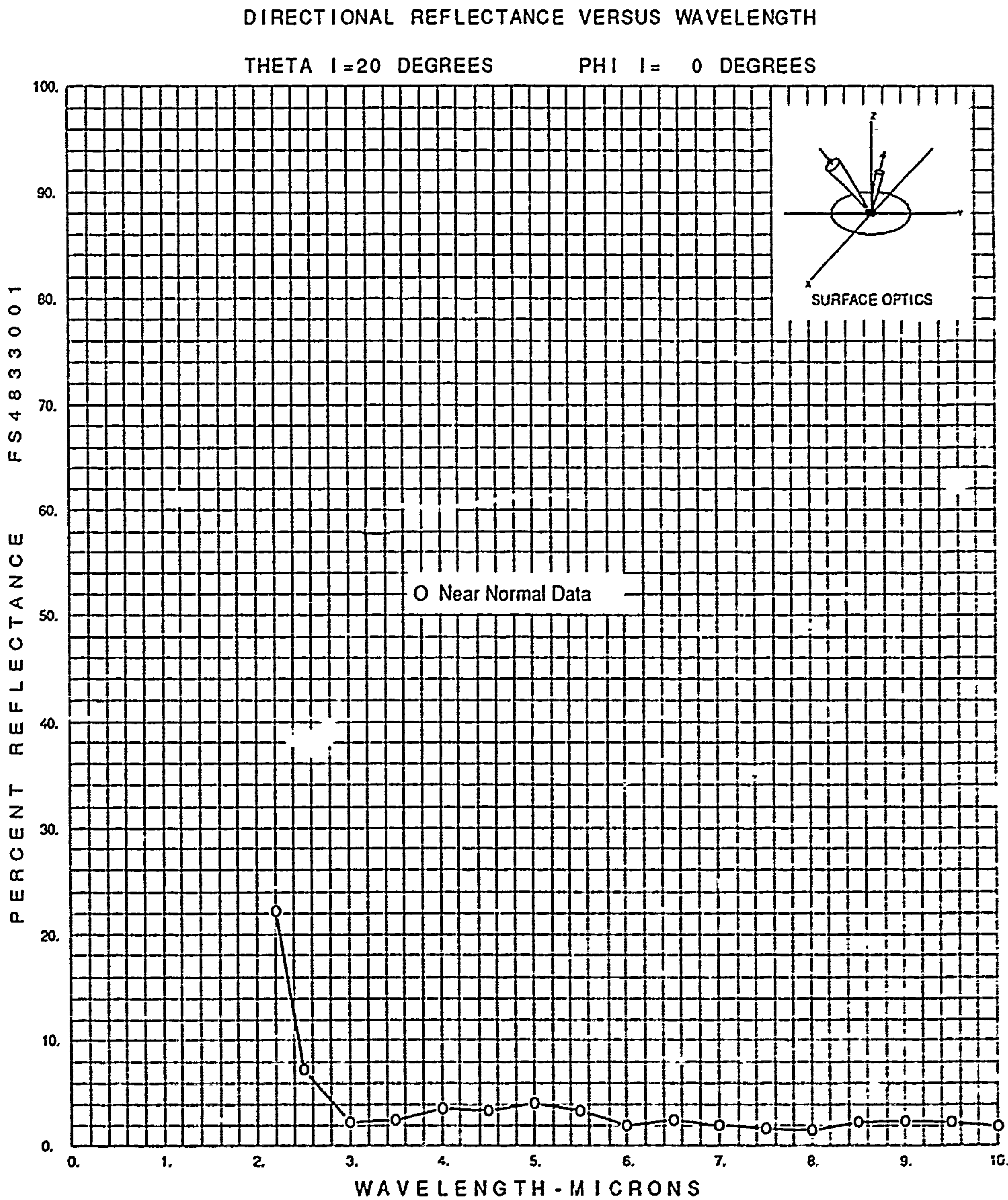

FIGURE A-3. SPECTRAL SCIENCES: BARK SAMPLE #1, 2PM, WEST SIDE, 55" UP. DIRECTIONAL REFLECTANCE VS. WAVELENGTH BANDWIDTH 2.2 TO 10.0 MICROMETERS DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX A

TABLE A-1. SPECTRAL SCIENCES: BARK SAMPLE #1,
2PM, WEST SIDE, 55" UP. PHI = 0
DIRECTIONAL REFLECTANCE VS. WAVELENGTH - ERAS DATA
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

FS48330015001		1	1								
FS48330015101		SPECTRAL SCIENCES: BARK SAMPLE #1, 2PM, WEST SIDE, 55" UP.									
FS48330015102		PHI = 0									
FS48330015103		UNCORRECTED FOR INSTRUMENTATION POLARIZATION EFFECTS									
FS48330017001		092090									
FS48330019001	1	001	1	.3	10.	58				20.	0.
FS48330019201	1	.3	4.4	.35	4.7	.4	6.2	.45	7.7	.5	9.7
FS48330019202	1	.55	16.2	.575	17.4	.6	17.4	.625	17.4	.675	14.4
FS48330019203	1	.7	24.4	.725	54.4	.75	65.0	.775	68.5	.8	70.3
FS48330019204	1	.9	74.5	.925	75.6	.975	71.0	1.	72.7	1.05	76.1
FS48330019205	1	1.1	76.3	1.125	76.4	1.175	62.8	1.2	61.5	1.25	66.8
FS48330019206	1	1.3	66.0	1.35	50.6	1.4	31.1	1.425	21.4	1.475	21.7
FS48330019207	1	1.5	34.4	1.6	39.1	1.65	41.5	1.7	35.8	1.725	33.0
FS48330019208	1	1.8	32.6	1.825	32.5	1.875	24.6	1.9	17.1	1.925	9.5
FS48330019209	1	2.	15.2	2.2	22.2	2.5	7.3	3.	2.3	3.5	2.5
FS48330019210	1	4.	3.6	4.5	3.3	5.	4.1	5.5	3.3	6.	2.0
FS48330019211	1	6.5	2.5	7.	2.0	7.5	1.7	8.	1.5	8.5	2.2
FS48330019212	1	9.	2.4	9.5	2.3	10.	1.9				

APPENDIX A

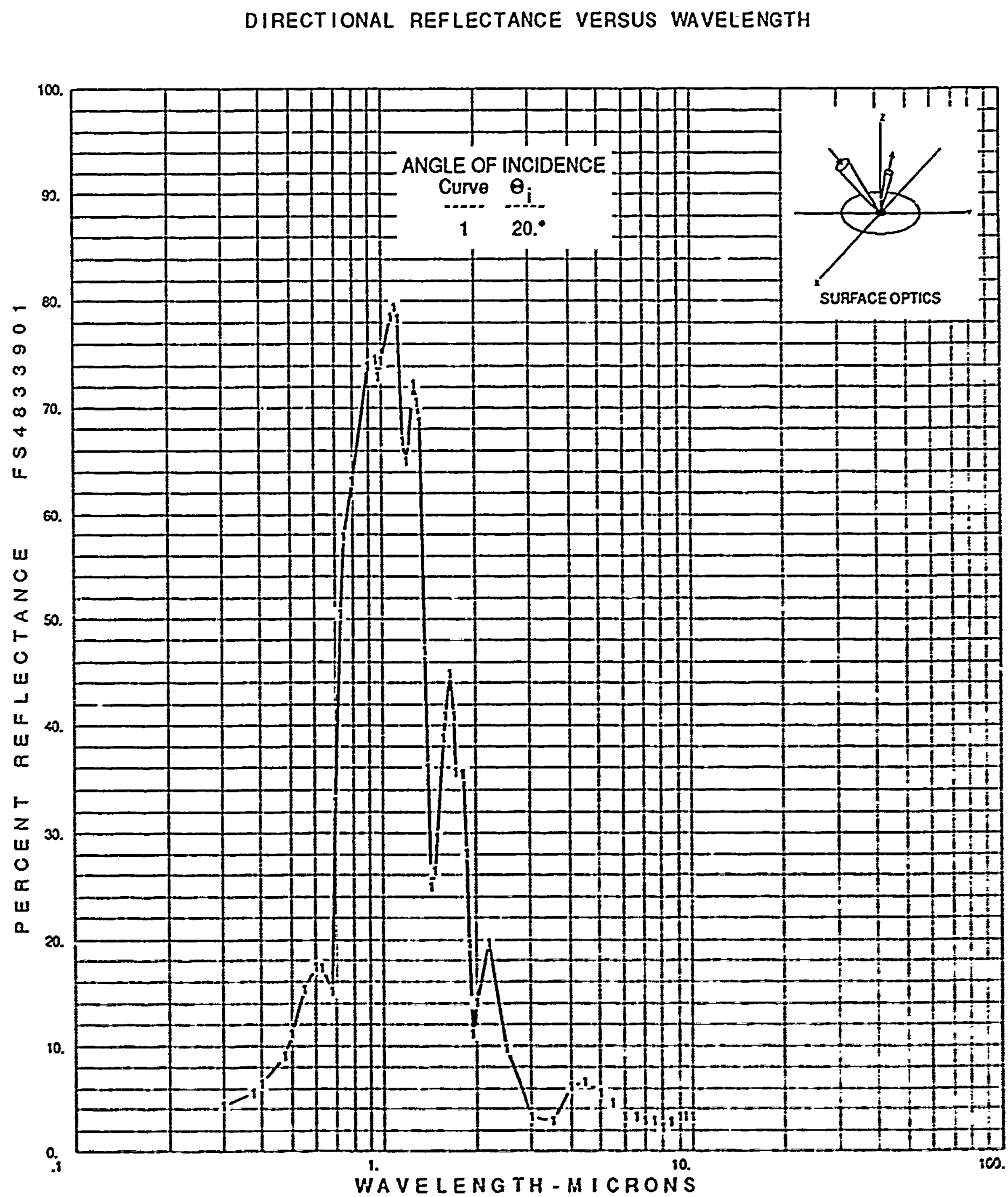

FIGURE A-4. SPECTRAL SCIENCES: BARK SAMPLE #1,
2 PM. WEST SIDE. 55" UP.
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 10.0 MICROMETERS. PHI = 90
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX A

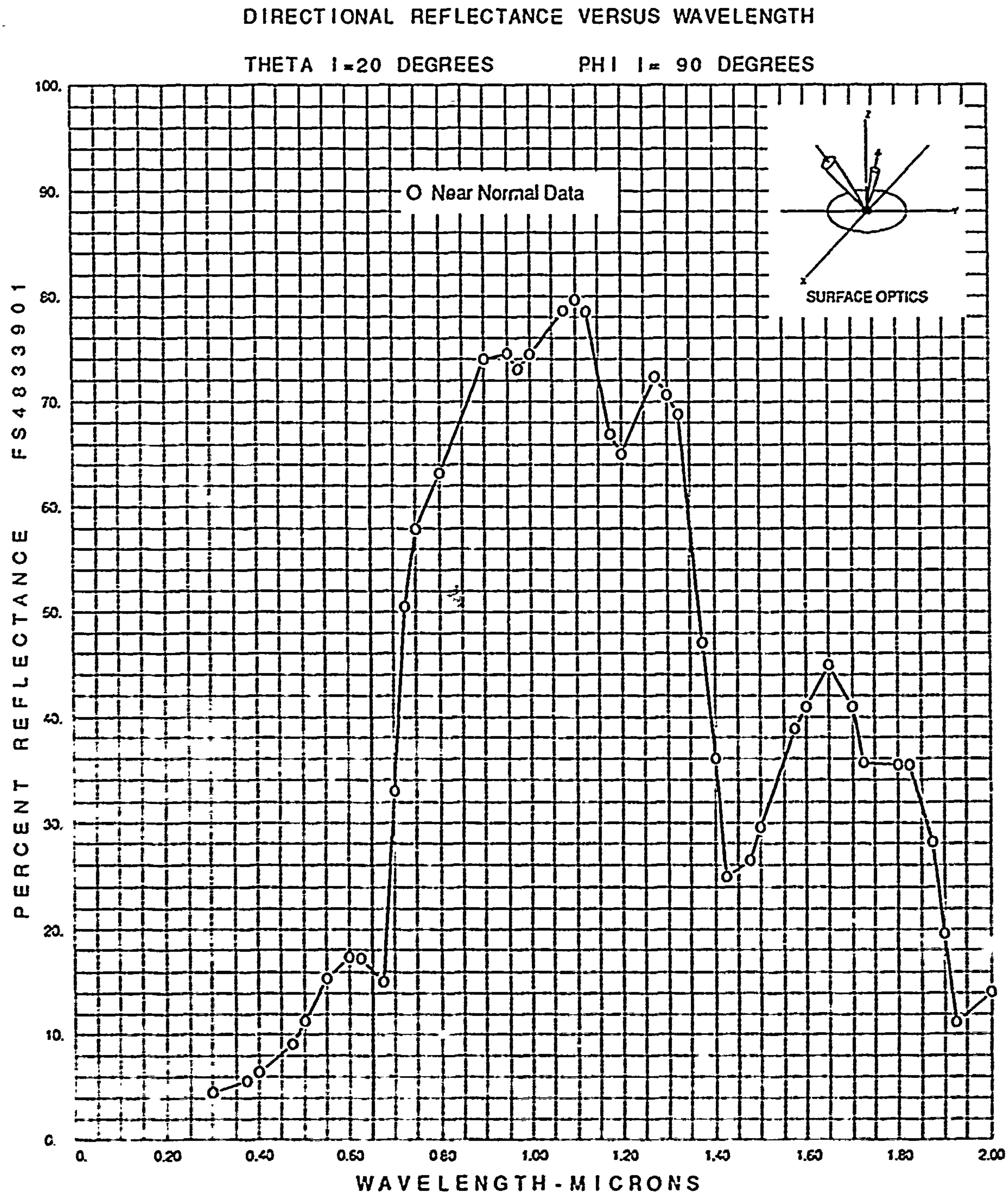

FIGURE A-5. SPECTRAL SCIENCES: BARK SAMPLE #1,
2 PM. WEST SIDE. 55" UP.
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 2.0 MICROMETERS. PHI = 90
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX A

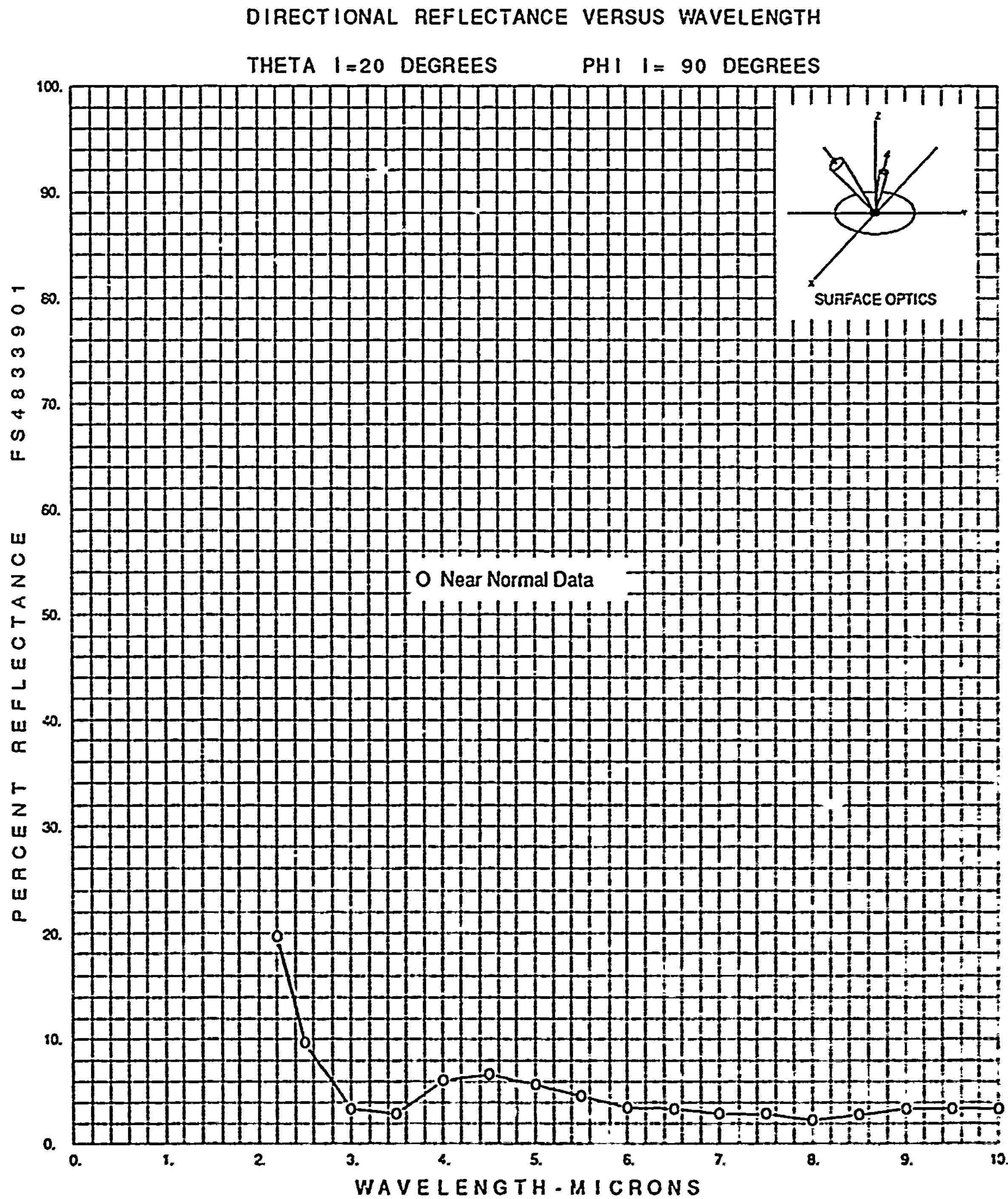

FIGURE A-6. SPECTRAL SCIENCES: BARK SAMPLE #1,
2 PM. WEST SIDE. 55" UP.
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 2.2 TO 10.0 MICROMETERS. PHI = 90
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX A

TABLE A-2. SPECTRAL SCIENCES: BARK SAMPLE #1, 2 PM, WEST SIDE, 55" UP. PHI = 90
DIRECTIONAL REFLECTANCE VS. WAVELENGTH - ERAS DATA
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

FS48339015001		1	1								
FS48339015101		SPECTRAL SCIENCES: BARK SAMPLE #1, 2 PM, WEST SIDE, 55" UP.									
FS48339015102		PHI = 90									
FS48339015103		UNCORRECTED FOR INSTRUMENTATION POLARIZATION EFFECTS									
FS48339017001		092090									
FS48339019001	1	001	1	.3	10.	58				20.	90.
FS48339019201	1	.3	4.4	.375	5.5	.4	6.4	.475	9.1	.5	11.2
FS48339019202	1	.55	15.4	.6	17.4	.625	17.3	.675	15.1	.7	32.9
FS48339019203	1	.725	50.5	.75	57.8	.8	63.2	.9	74.0	.95	74.5
FS48339019204	1	.975	73.0	1.	74.4	1.075	78.6	1.1	79.5	1.125	78.4
FS48339019205	1	1.175	66.9	1.2	65.0	1.275	72.3	1.3	70.6	1.325	68.8
FS48339019206	1	1.375	47.0	1.4	36.0	1.425	24.9	1.475	26.5	1.5	29.6
FS48339019207	1	1.575	38.9	1.6	40.9	1.65	44.9	1.7	40.9	1.725	35.7
FS48339019208	1	1.8	35.5	1.825	35.5	1.875	28.1	1.9	19.6	1.925	11.1
FS48339019209	1	2.	14.1	2.2	19.7	2.5	9.7	3.	3.3	3.5	2.9
FS48339019210	1	4.	6.1	4.5	6.6	5.	5.6	5.5	4.6	6.	3.4
FS48339019211	1	6.5	3.3	7.	2.9	7.5	2.9	8.	2.3	8.5	2.8
FS48339019212	1	9.	3.3	9.5	3.3	10.	3.3				

APPENDIX A

DIRECTIONAL REFLECTANCE VERSUS WAVELENGTH

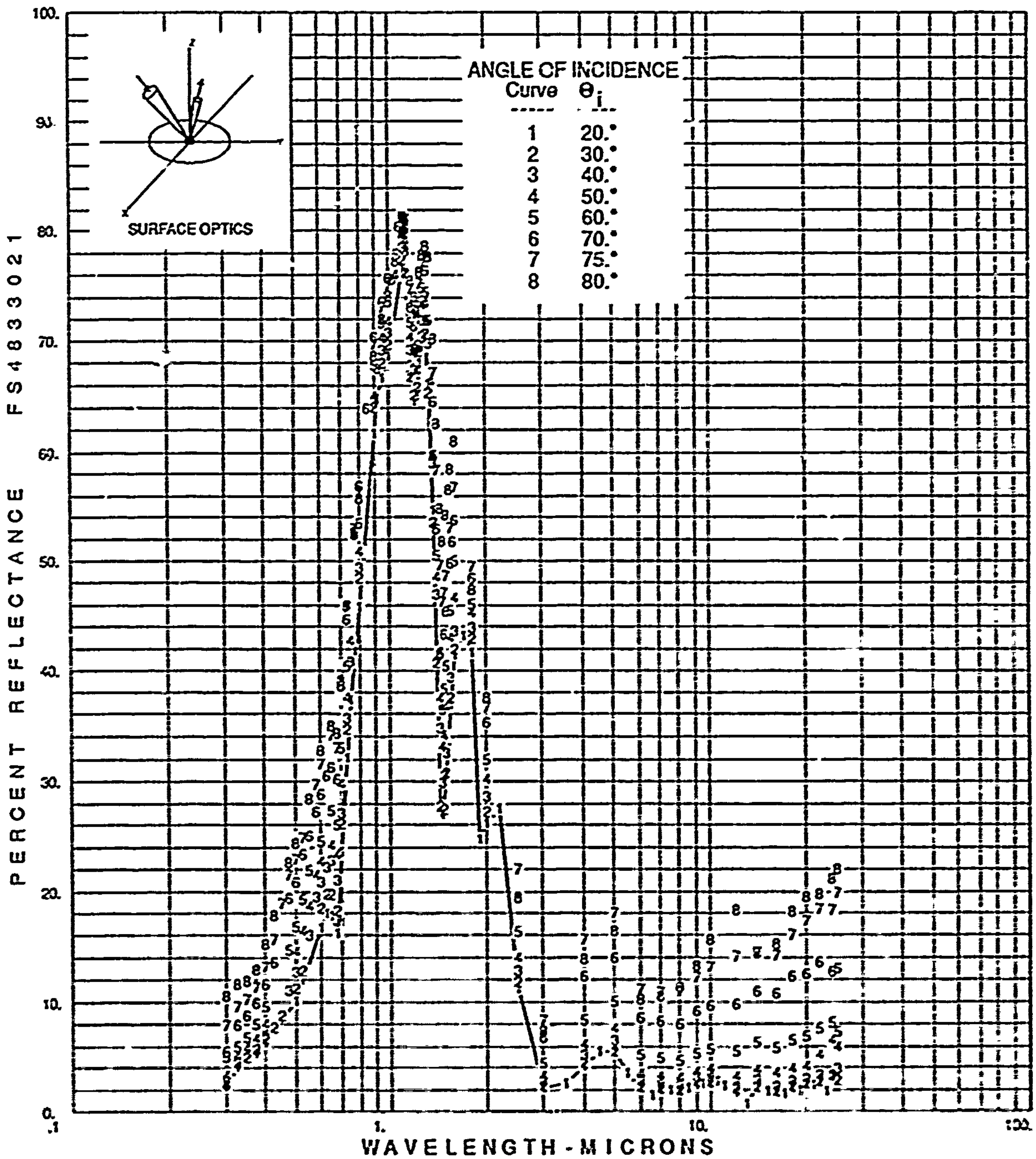

FIGURE A-7. SPECTRAL SCIENCES: BARK SAMPLE #1, 2PM, WEST SIDE, 55" UP. DIRECTIONAL REFLECTANCE VS. WAVELENGTH BANDWIDTH 0.3 TO 25.0 MICROMETERS DATA CORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX A

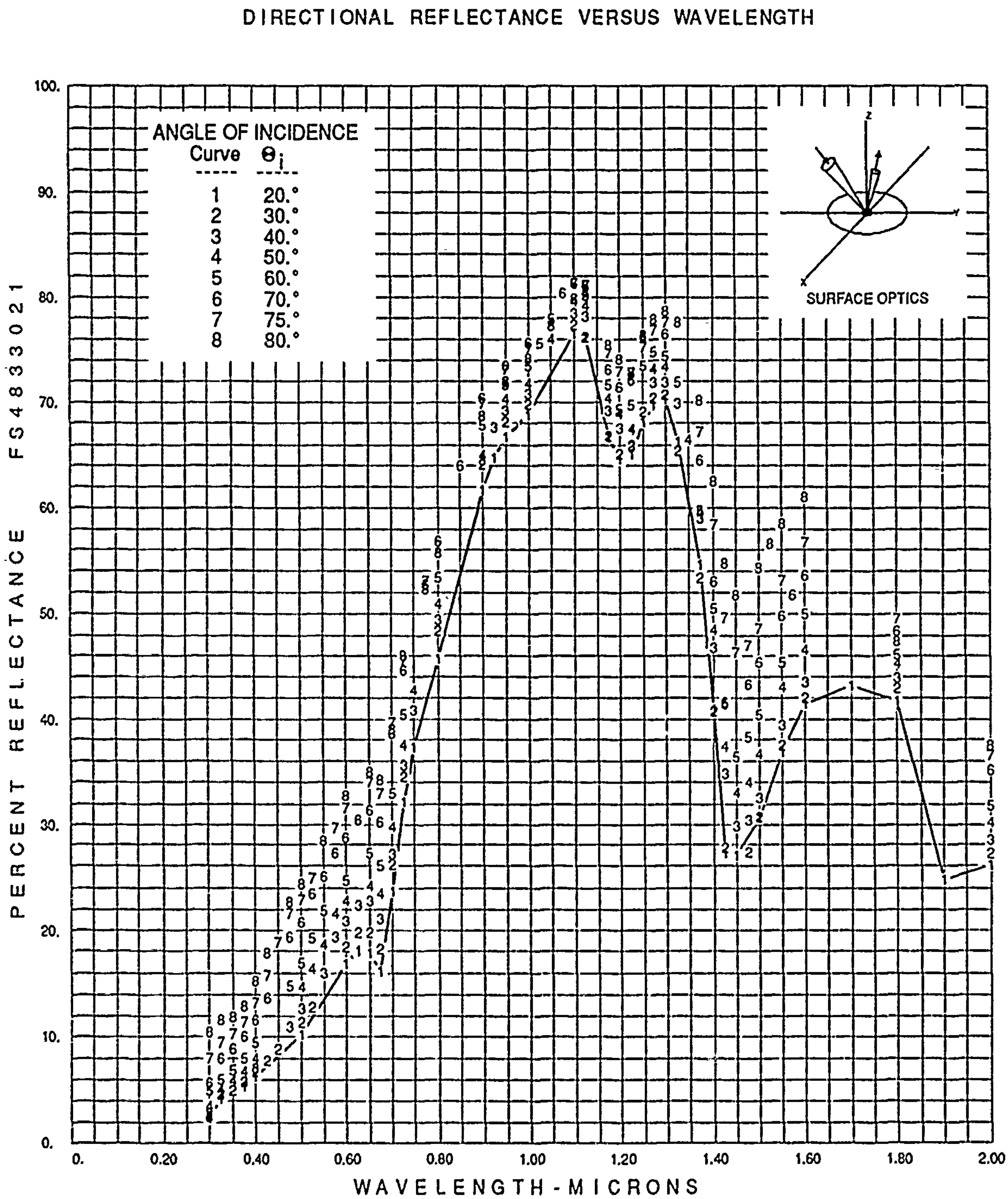

FIGURE A-8. SPECTRAL SCIENCES: BARK SAMPLE #1, 2PM, WEST SIDE, 55" UP. DIRECTIONAL REFLECTANCE VS. WAVELENGTH BANDWIDTH 0.3 TO 2.0 MICROMETERS DATA CORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX A

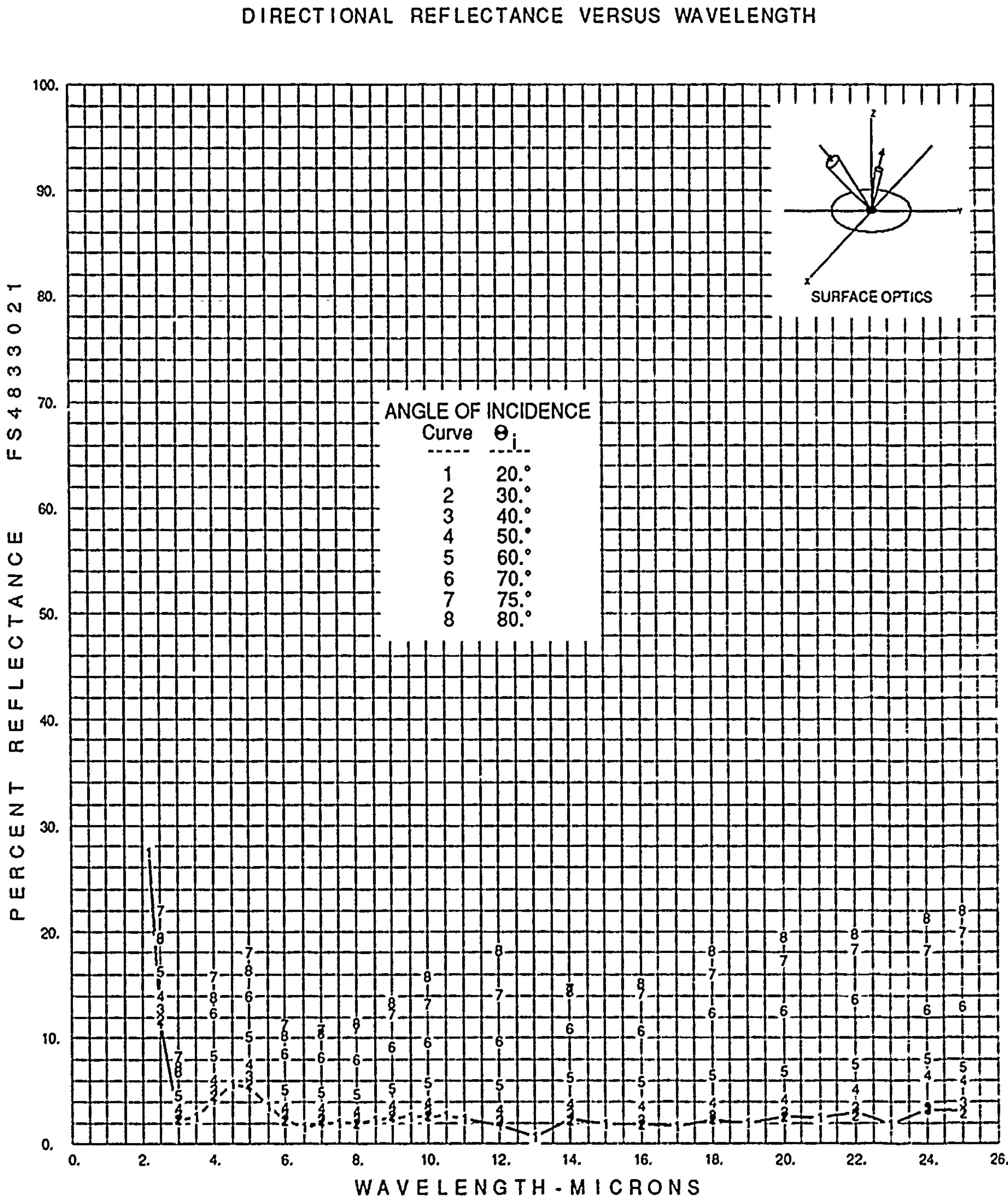

FIGURE A-9. SPECTRAL SCIENCES: BARK SAMPLE #1,
2PM, WEST SIDE, 55" UP.
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 2.2 TO 25.0 MICROMETERS
DATA CORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX A

TABLE A-3. SPECTRAL SCIENCES: BARK SAMPLE #1, 2 PM, WEST SIDE, 55" UP. PHI = 0
DIRECTIONAL REFLECTANCE VS. WAVELENGTH - ERAS DATA
DATA CORRECTED FOR INSTRUMENTATION POLARIZATION

```
FS48330215001          8      1
FS48330215101        SPECTRAL SCIENCES: BARK SAMPLE #1, 2PM, WEST SIDE, 55" UP.
FS48330215102        PHI=0
FS48330215103        CORRECTED FOR INSTRUMENTATION POLARIZATION EFFECTS
FS48330217001        091690
FS48330219001   1         001    1      .3     25.   70                              20.      0.
FS48330219201   1      .3    2.4   .325    4.2   .375    5.4     .4    6.3      .5   10.2
FS48330219202   1      .6   16.8   .625   18.0    .65   17.8   .675   16.2      .7   23.6
FS48330219203   1    .725   32.2    .75   37.3     .8   45.8     .9   61.7    .925   64.8
FS48330219204   1     .95   66.7     1.   68.8    1.1   76.6  1.125   76.2   1.175   66.7
FS48330219205   1     1.2   64.6  1.225   65.1   1.25   68.1  1.275   69.7     1.3   70.3
FS48330219206   1   1.325   66.2  1.375   54.7    1.4   41.0  1.425   27.2    1.45   27.0
FS48330219207   1     1.5   30.7   1.55   36.9    1.6   41.4    1.7   43.3     1.8   41.7
FS48330219208   1     1.9   24.7     2.   26.2    2.2   27.5    2.5   11.3      3.    2.2
FS48330219209   1     3.5    2.6     4.    4.2    4.5    5.6     5.    5.4     5.5    3.6
FS48330219210   1      6.    2.2    6.5    1.6     7.    2.0    7.5    2.0      8.    2.0
FS48330219211   1     8.5    2.2     9.    2.5    9.5    2.6    10.    2.6    10.5    2.7
FS48330219212   1     11.    2.4    12.    1.8    13.    0.7    14.    2.4     15.    1.9
FS48330219213   1     16.    1.9    17.    1.7    18.    2.2    19.    2.0     20.    2.6
FS48330219214   1     21.    2.5    22.    3.0    23.    1.9    24.    3.2     25.    3.1
FS48330219001   2         001    1      .3     25.   54                              30.      0.
FS48330219201   2      .3    2.8   .325    4.5    .35    5.0   .375    5.8      .4    6.7
FS48330219202   2    .425    7.7    .45    8.8     .5   11.3   .525   12.8      .6   18.5
FS48330219203   2    .625   19.8    .65   19.8   .675   18.3     .7   26.1    .725   34.6
FS48330219204   2      .8   48.4     .9   64.1    .95   68.1     1.   69.8     1.1   77.4
FS48330219205   2   1.125   76.2  1.175   66.8    1.2   65.1  1.225   65.9    1.25   69.1
FS48330219206   2   1.275   70.5    1.3   70.7  1.325   65.4  1.375   53.5     1.4   40.7
FS48330219207   2   1.425   27.8  1.475   27.4    1.5   30.8   1.55   37.6     1.6   42.0
FS48330219208   2     1.8   42.9     2.   27.2    2.5   11.8     3.    2.4      4.    4.5
FS48330219209   2      5.    5.6     6.    2.3     7.    2.2     8.    2.0      9.    2.7
FS48330219210   2     10.    2.7    12.    2.1    14.    2.3    16.    1.9     18.    2.4
FS48330219211   2     20.    2.6    22.    2.7    24.    3.3    25.    2.9
FS48330219001   3         001    1      .3     25.   55                              40.      0.
FS48330219201   3      .3    2.5   .325    4.5   .375    5.8     .4    7.1    .475   11.0
FS48330219202   3      .5   12.7    .55   16.0   .575   19.4     .6   20.9    .625   22.3
FS48330219203   3     .65   22.8   .675   21.1     .7   27.1   .725   35.7     .75   40.8
FS48330219204   3      .8   49.4     .9   64.5   .925   67.6    .95   69.2      1.   70.8
FS48330219205   3     1.1   78.5  1.125   78.2  1.175   69.2    1.2   67.5   1.225   65.8
FS48330219206   3   1.275   71.9    1.3   71.9  1.325   69.9  1.375   59.0     1.4   46.9
FS48330219207   3   1.425   34.8   1.45   29.9  1.475   30.4    1.5   32.5    1.55   39.4
FS48330219208   3     1.6   43.6    1.8   43.9     2.   28.6    2.5   12.8      3.    2.8
FS48330219209   3      4.    5.2     5.    6.5     6.    2.8     7.    2.5      8.    2.4
FS48330219210   3      9.    3.1    10.    3.1    12.    2.3    14.    2.9     16.    2.3
FS48330219211   3     18.    2.7    20.    3.0    22.    3.4    24.    3.4     25.    3.9
FS48330219001   4         001    1      .3     25.   55                              50.      0.
FS48330219201   4      .3    3.4   .325    5.1    .35    5.9   .375    6.7      .4    8.0
FS48330219202   4      .5   14.6   .525   16.4    .55   18.7   .575   21.5      .6   22.7
FS48330219203   4     .65   24.2   .675   23.4     .7   29.8   .725   37.6     .75   42.7
```

APPENDIX A

TABLE A-3. (CONTINUED)

FS48330219204	4	.8	50.9	.9	65.0	.95	70.3	1.	71.8	1.05	76.0
FS48330219205	4	1.1	79.6	1.125	79.2	1.175	70.4	1.2	68.9	1.225	67.4
FS48330219206	4	1.275	73.2	1.3	73.4	1.35	66.4	1.375	59.6	1.4	48.5
FS48330219207	4	1.425	37.4	1.45	33.1	1.475	34.1	1.5	36.8	1.55	43.0
FS48330219208	4	1.6	46.7	1.8	45.3	2.	30.2	2.5	14.0	3.	3.3
FS48330219209	4	4.	6.1	5.	7.6	6.	3.5	7.	3.3	8.	3.1
FS48330219210	4	9.	3.7	10.	3.9	12.	3.2	14.	3.8	16.	3.6
FS48330219211	4	18.	3.9	20.	4.2	22.	5.2	24.	6.5	25.	6.0
FS48330219001	5	001	1	.3	25.	56				60.	0.
FS48330219201	5	.3	5.0	.325	6.0	.35	6.8	.375	8.0	.4	9.5
FS48330219202	5	.475	14.7	.5	16.9	.525	19.2	.55	21.9	.6	24.6
FS48330219203	5	.65	27.3	.675	26.0	.7	33.0	.725	40.4	.8	53.4
FS48330219204	5	.9	67.8	.95	71.7	1.	73.5	1.025	75.6	1.05	77.9
FS48330219205	5	1.1	79.9	1.125	80.2	1.175	71.7	1.2	69.3	1.225	69.7
FS48330219206	5	1.25	73.5	1.275	74.8	1.3	74.4	1.325	71.9	1.375	59.7
FS48330219207	5	1.4	50.5	1.425	41.4	1.45	36.5	1.475	38.3	1.5	40.4
FS48330219208	5	1.55	45.5	1.6	50.0	1.8	46.1	2.	31.9	2.5	16.3
FS48330219209	5	3.	4.5	4.	8.4	5.	10.1	6.	5.2	7.	4.9
FS48330219210	5	8.	4.7	9.	5.3	10.	5.8	12.	5.5	14.	6.3
FS48330219211	5	16.	5.9	18.	6.5	20.	6.9	22.	7.6	24.	8.1
FS48330219212	5	25.	7.3								
FS48330219001	6	001	1	.3	25.	58				70.	0.
FS48330219201	6	.3	5.6	.325	7.9	.35	8.8	.375	10.0	.4	11.6
FS48330219202	6	.425	13.6	.475	19.3	.5	20.8	.525	23.4	.55	25.1
FS48330219203	6	.575	27.2	.6	28.8	.625	30.4	.65	31.3	.675	30.2
FS48330219204	6	.7	38.6	.725	44.7	.775	52.7	.8	56.8	.85	64.0
FS48330219205	6	.9	70.4	.95	73.5	1.	75.7	1.075	80.4	1.1	81.3
FS48330219206	6	1.125	81.1	1.175	73.1	1.2	71.4	1.225	72.1	1.25	76.2
FS48330219207	6	1.3	76.5	1.375	64.5	1.4	53.0	1.425	41.6	1.475	43.4
FS48330219208	6	1.5	45.4	1.55	49.8	1.575	51.8	1.6	53.7	1.8	48.4
FS48330219209	6	2.	35.3	2.5	19.5	3.	6.8	4.	12.3	5.	14.0
FS48330219210	6	6.	8.6	7.	8.2	8.	8.0	9.	9.2	10.	9.6
FS48330219211	6	12.	9.7	14.	10.9	16.	10.7	18.	12.3	20.	12.6
FS48330219212	6	22.	13.6	24.	12.7	25.	13.0				
FS48330219001	7	001	1	.3	25.	56				75.	0.
FS48330219201	7	.3	7.9	.325	9.5	.35	10.3	.375	11.4	.4	13.2
FS48330219202	7	.425	15.7	.45	18.9	.475	21.5	.5	22.9	.525	24.8
FS48330219203	7	.575	29.7	.6	31.5	.65	34.1	.675	33.0	.7	39.6
FS48330219204	7	.725	45.7	.775	53.0	.8	56.3	.9	69.8	.95	73.1
FS48330219205	7	1.	75.1	1.1	81.3	1.125	81.1	1.175	74.7	1.2	72.9
FS48330219206	7	1.225	72.8	1.25	75.3	1.275	76.9	1.3	77.6	1.375	67.2
FS48330219207	7	1.4	58.4	1.425	49.6	1.45	46.3	1.475	47.0	1.5	48.6
FS48330219208	7	1.55	53.1	1.6	56.7	1.8	49.5	2.	36.7	2.5	22.0
FS48330219209	7	3.	8.3	4.	15.7	5.	18.0	6.	11.2	7.	10.8
FS48330219210	7	8.	10.9	9.	12.2	10.	13.2	12.	14.1	14.	14.5
FS48330219211	7	16.	14.2	18.	16.0	20.	17.3	22.	18.4	24.	18.3
FS48330219212	7	25.	19.9								
FS48330219001	8	001	1	.3	25.	56				80.	0.

APPENDIX A

TABLE A-3. (CONTINUED)

FS48330219201	8	.3	10.5	.325	11.6	.35	11.9	.375	12.9	.4	15.3
FS48330219202	8	.425	17.8	.475	22.6	.5	24.4	.55	28.4	.6	32.7
FS48330219203	8	.65	35.0	.675	34.3	.7	39.1	.725	46.0	.775	52.4
FS48330219204	8	.8	55.8	.9	68.7	.95	72.0	1.	74.2	1.05	77.3
FS48330219205	8	1.1	79.9	1.125	80.5	1.175	75.5	1.2	74.1	1.225	72.7
FS48330219206	8	1.25	76.4	1.275	77.9	1.3	78.7	1.325	77.6	1.375	70.2
FS48330219207	8	1.4	62.5	1.425	54.8	1.45	51.8	1.5	54.3	1.525	56.6
FS48330219208	8	1.55	58.5	1.6	61.0	1.8	47.4	2.	37.6	2.5	19.3
FS48330219209	8	3.	7.4	4.	13.9	5.	16.4	6.	10.3	7.	10.5
FS48330219210	8	8.	11.4	9.	13.3	10.	15.7	12.	18.3	14.	14.4
FS48330219211	8	16.	15.2	18.	18.2	20.	19.5	22.	19.8	24.	21.2
FS48330219212	8	25.	22.0								

APPENDIX A

TABLE A-4. SPECTRAL SCIENCES: BARK SAMPLE #1, 2PM, WEST SIDE, 55" UP. PHI = 0 DIRECTIONAL AND HEMISPHERICAL EMITTANCE AS A FUNCTION OF INCIDENT ANGLE AND TEMPERATURE DATA CORRECTED FOR INSTRUMENTATION POLARIZATION

FS4833021: SPECTRAL SCIENCES: BARK SAMPLE #1, 2PM, WEST SIDE, 55" UP. PHI=0

Emittance tabulated as a function of zenith angle and temperature:

Zenith angle (degrees)	Wavelength range (microns)	Temperature (degrees Kelvin) 100	200	300	400	500	600
20	0.300 - 25.000	0.976	0.978	0.978	0.976	0.973	0.968
30	0.300 - 25.000	0.973	0.976	0.976	0.974	0.970	0.966
40	0.300 - 25.000	0.969	0.972	0.971	0.969	0.966	0.961
50	0.300 - 25.000	0.952	0.959	0.961	0.960	0.957	0.952
60	0.300 - 25.000	0.929	0.936	0.940	0.939	0.937	0.932
70	0.300 - 25.000	0.875	0.888	0.896	0.898	0.897	0.894
75	0.300 - 25.000	0.828	0.847	0.859	0.863	0.864	0.862
80	0.300 - 25.000	0.809	0.829	0.844	0.854	0.859	0.862
Hemispherical emittance:		0.928	0.934	0.937	0.936	0.934	0.930

APPENDIX A

TABLE A-5. SPECTRAL SCIENCES: BARK SAMPLE #1,
2PM, WEST SIDE, 55" UP. PHI = 0
SOLAR ABSORBPTANCE AS A FUNCTION OF INCIDENT ANGLE
DATA CORRECTED FOR INSTRUMENTATION POLARIZATION

```
FS4833021                                   Surface Optics Corp.
SPECTRAL SCIENCES: BARK SAMPLE #1, 2PM, WEST SIDE, 55" UP.  PHI=0

20 degrees: The exoatmospheric solar absorptance is 0.691.
30 degrees: The exoatmospheric solar absorptance is 0.680.
40 degrees: The exoatmospheric solar absorptance is 0.666.
50 degrees: The exoatmospheric solar absorptance is 0.651.
60 degrees: The exoatmospheric solar absorptance is 0.630.
70 degrees: The exoatmospheric solar absorptance is 0.599.
75 degrees: The exoatmospheric solar absorptance is 0.584.
80 degrees: The exoatmospheric solar absorptance is 0.577.
```

APPENDIX A

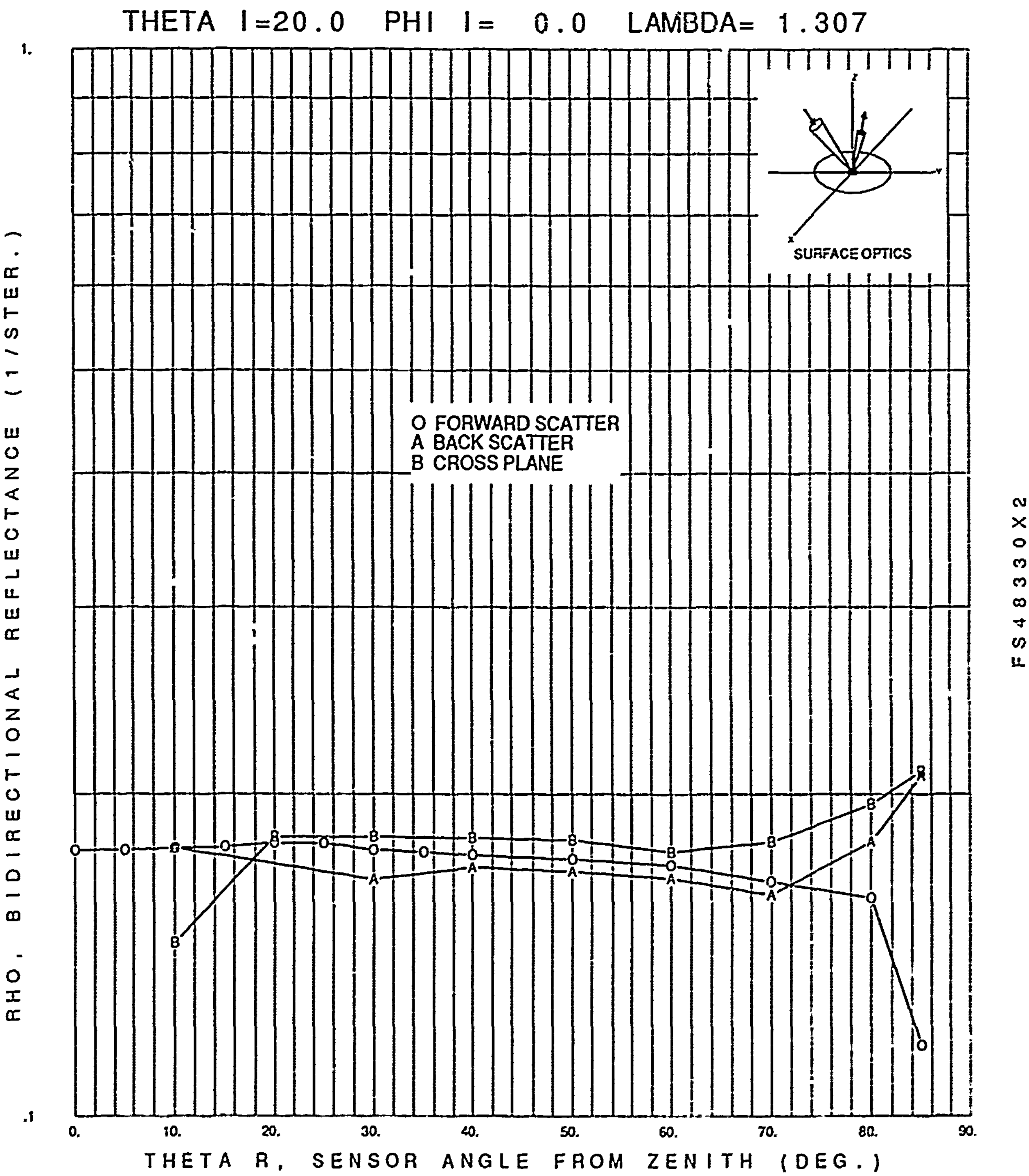

FIGURE A-10. SPECTRAL SCIENCES: BARK SAMPLE #1,
2PM, WEST SIDE, 55" UP
BIDIRECTIONAL REFLECTANCE VS. REFLECTED POLAR ANGLE
WAVELENGTH 1.307 MICROMETERS
INCIDENT POLAR ANGLE 20.0 DEGREES

APPENDIX A

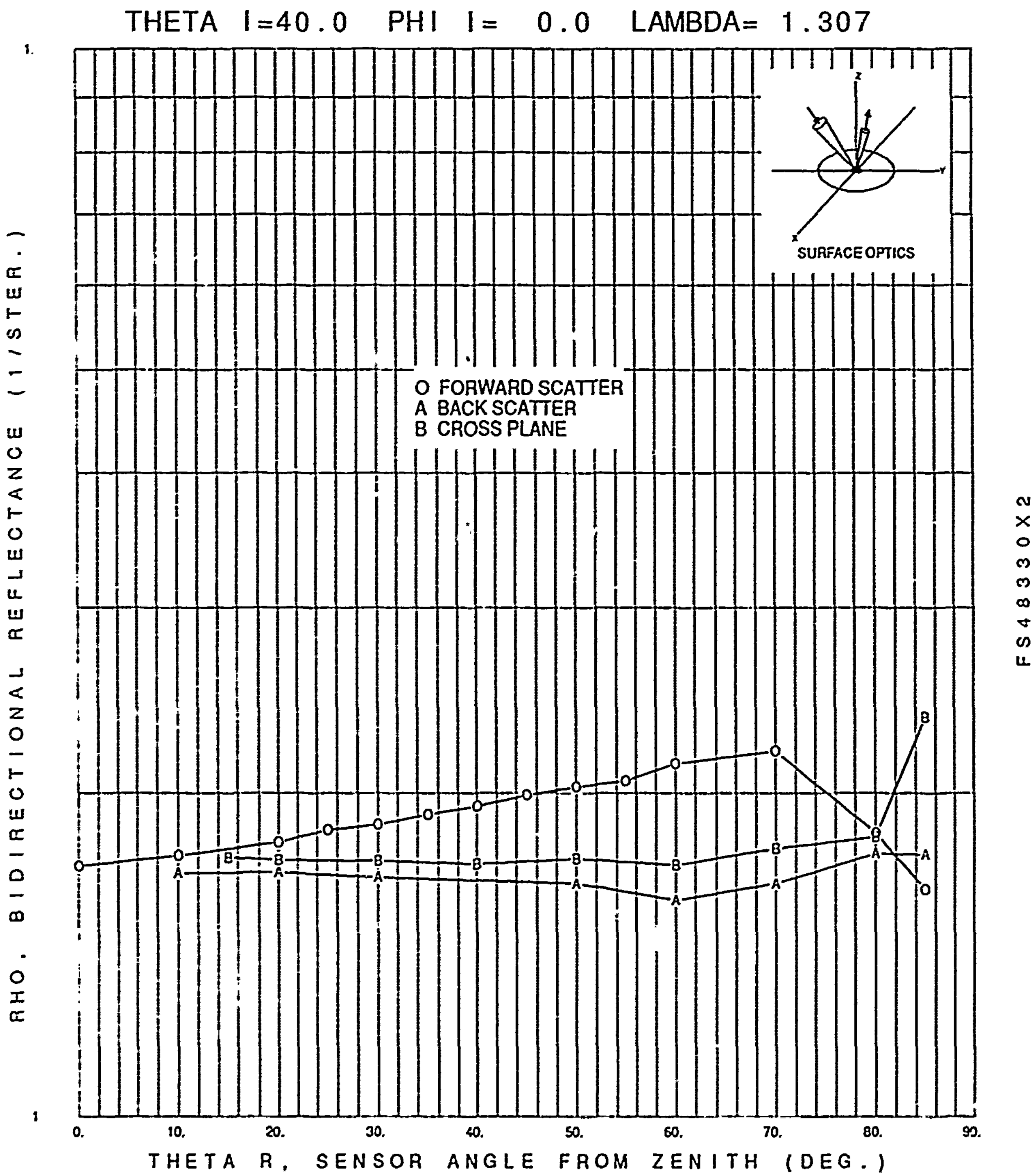

FIGURE A-11. SPECTRAL SCIENCES: BARK SAMPLE #1, 2PM, WEST SIDE, 55" UP
BIDIRECTIONAL REFLECTANCE VS. REFLECTED POLAR ANGLE
WAVELENGTH 1.307 MICROMETERS
INCIDENT POLAR ANGLE 40.0 DEGREES

APPENDIX A

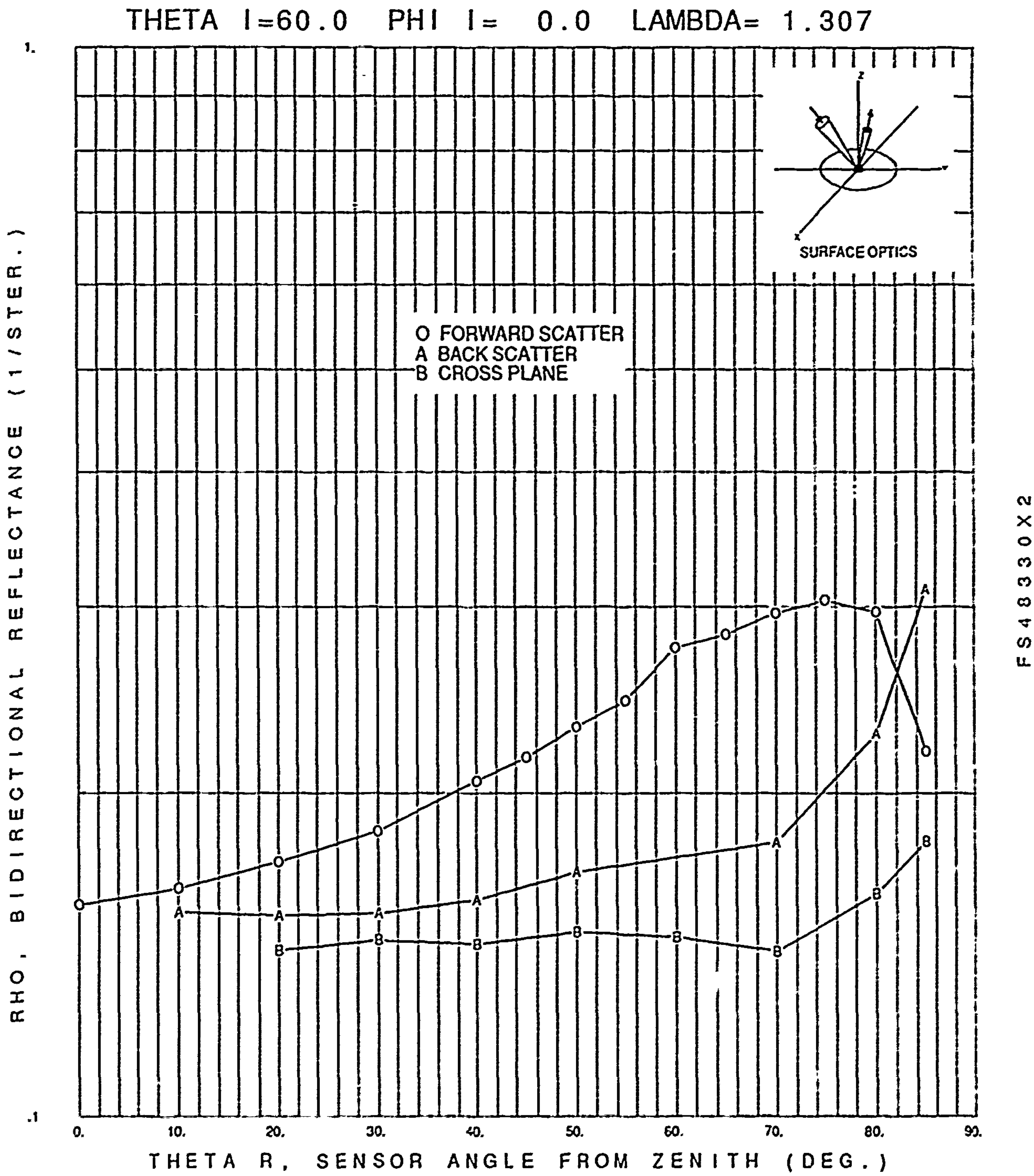

FIGURE A-12. SPECTRAL SCIENCES: BARK SAMPLE #1, 2PM, WEST SIDE, 55" UP
BIDIRECTIONAL REFLECTANCE VS. REFLECTED POLAR ANGLE
WAVELENGTH 1.307 MICROMETERS
INCIDENT POLAR ANGLE 60.0 DEGREES

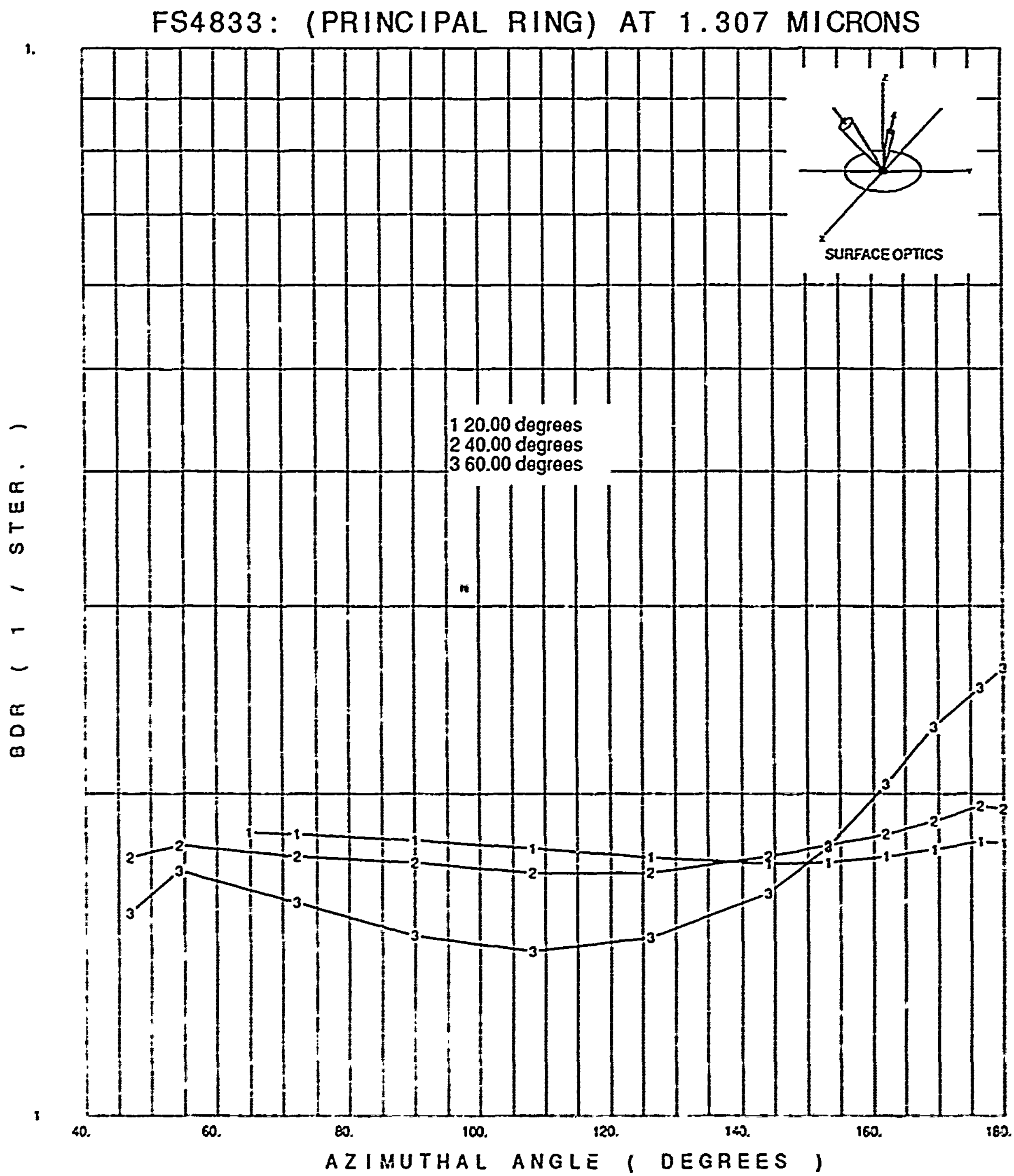

FIGURE A-13. SPECTRAL SCIENCES: BARK SAMPLE #1,
2PM, WEST SIDE, 55" UP, PHI = 0
BIDIRECTIONAL REFLECTANCE VS. REFLECTED AZIMUTH ANGLE
PRINCIPAL RING AT 1.307 MICROMETERS
INCIDENT POLAR ANGLES 20, 40 AND 60 DEGREES

APPENDIX A

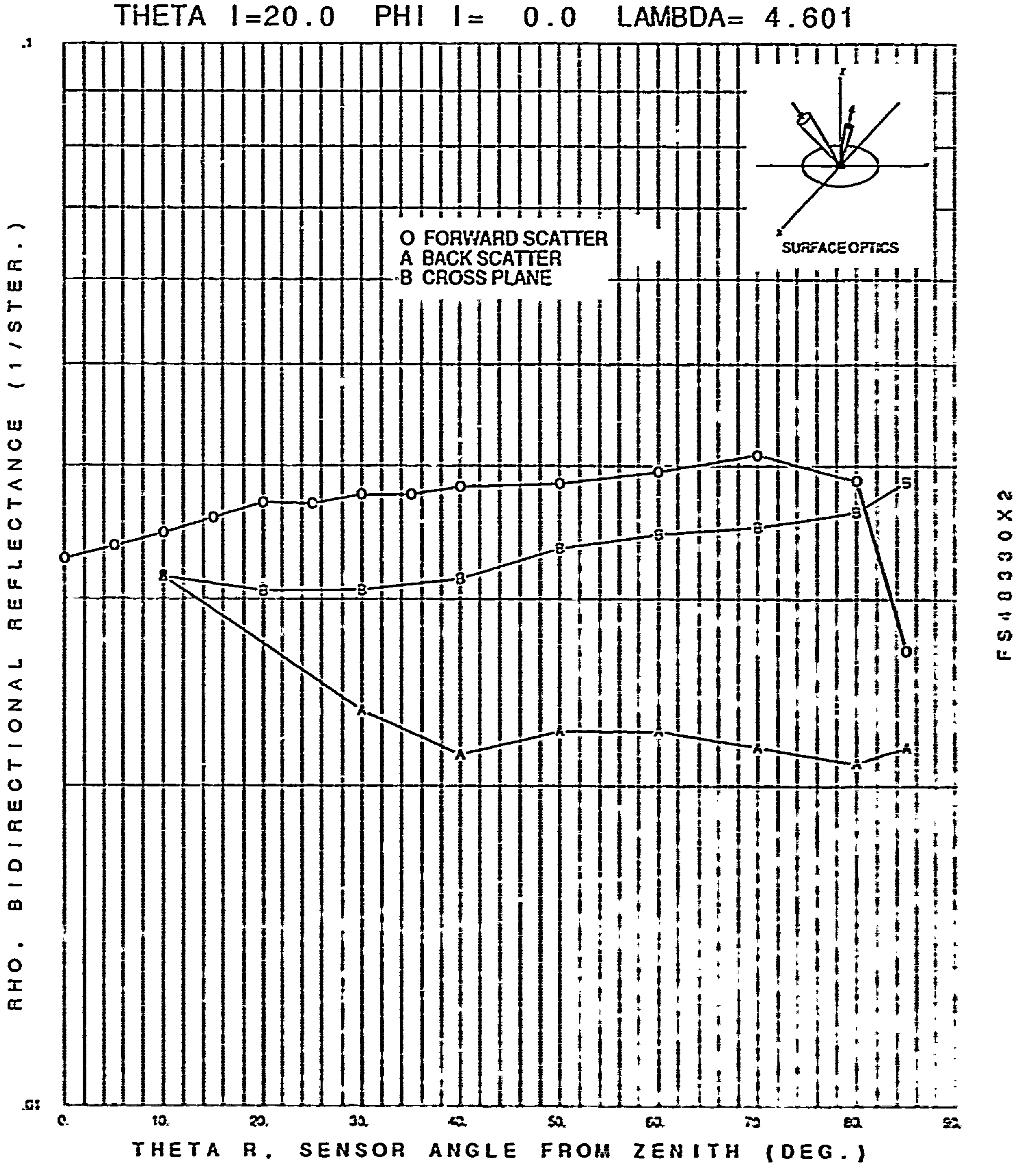

FIGURE A-14. SPECTRAL SCIENCES: BARK SAMPLE #1,
2PM. WEST SIDE. 55" UP
BIDIRECTIONAL REFLECTANCE VS. REFLECTED POLAR ANGLE
WAVELENGTH 4.601 MICROMETERS
INCIDENT POLAR ANGLE 20.0 DEGREES

APPENDIX A

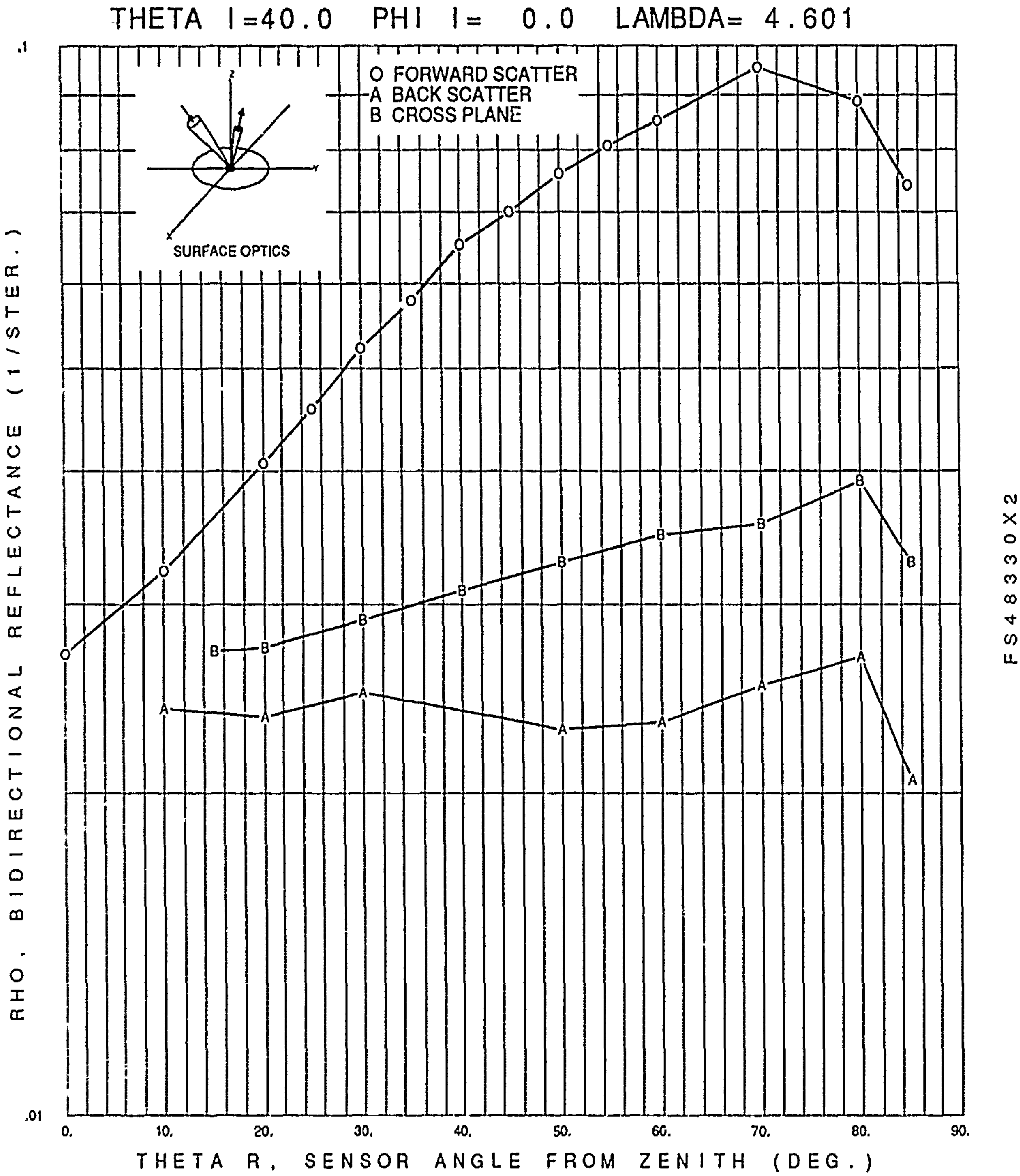

FIGURE A-15. SPECTRAL SCIENCES: BARK SAMPLE #1, 2PM, WEST SIDE, 55" UP BIDIRECTIONAL REFLECTANCE VS. REFLECTED POLAR ANGLE WAVELENGTH 4.601 MICROMETERS INCIDENT POLAR ANGLE 40.0 DEGREES

APPENDIX A

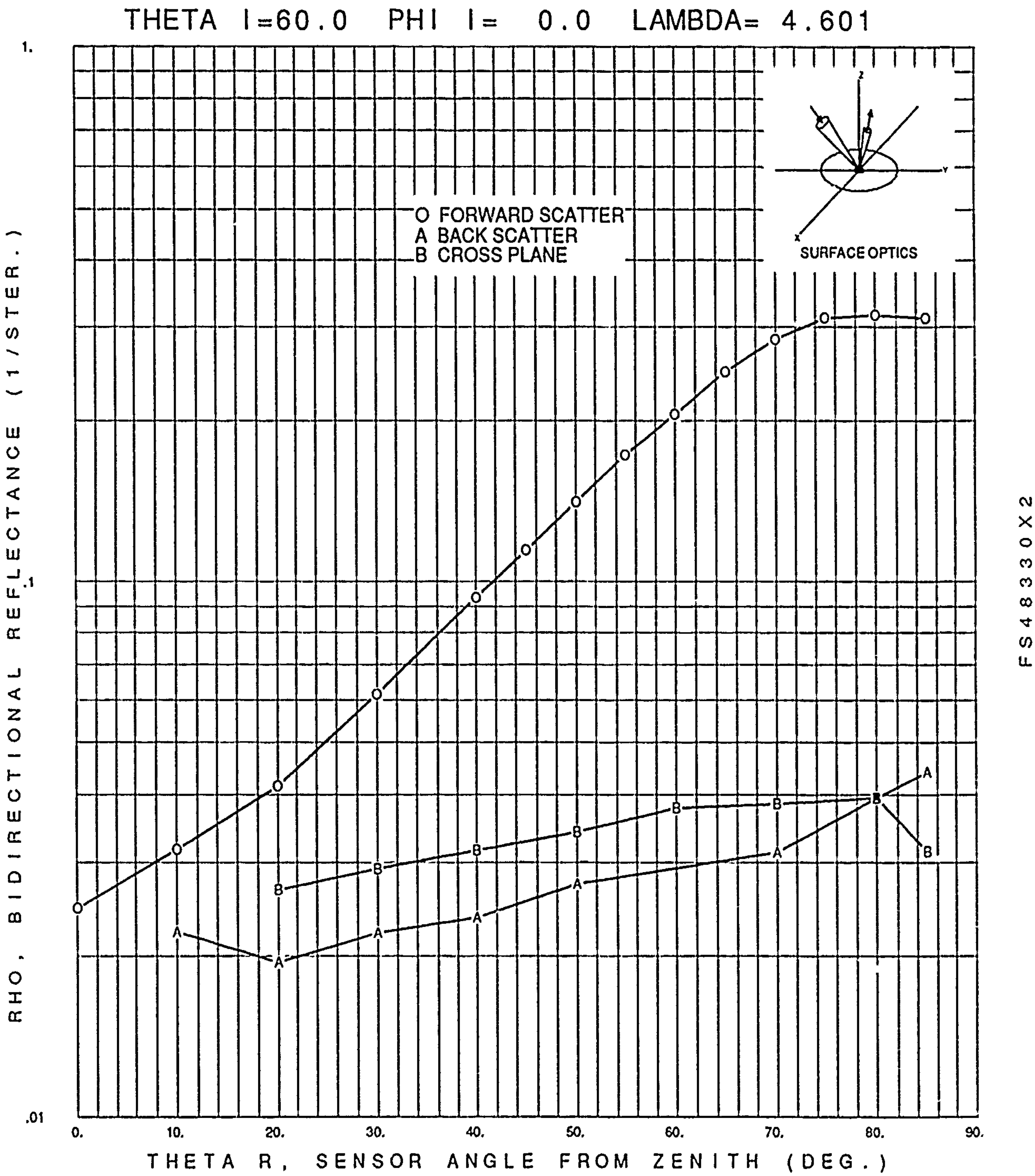

FIGURE A-16. SPECTRAL SCIENCES: BARK SAMPLE #1,
2PM, WEST SIDE, 55" UP
BIDIRECTIONAL REFLECTANCE VS. REFLECTED POLAR ANGLE
WAVELENGTH 4.601 MICROMETERS
INCIDENT POLAR ANGLE 60.0 DEGREES

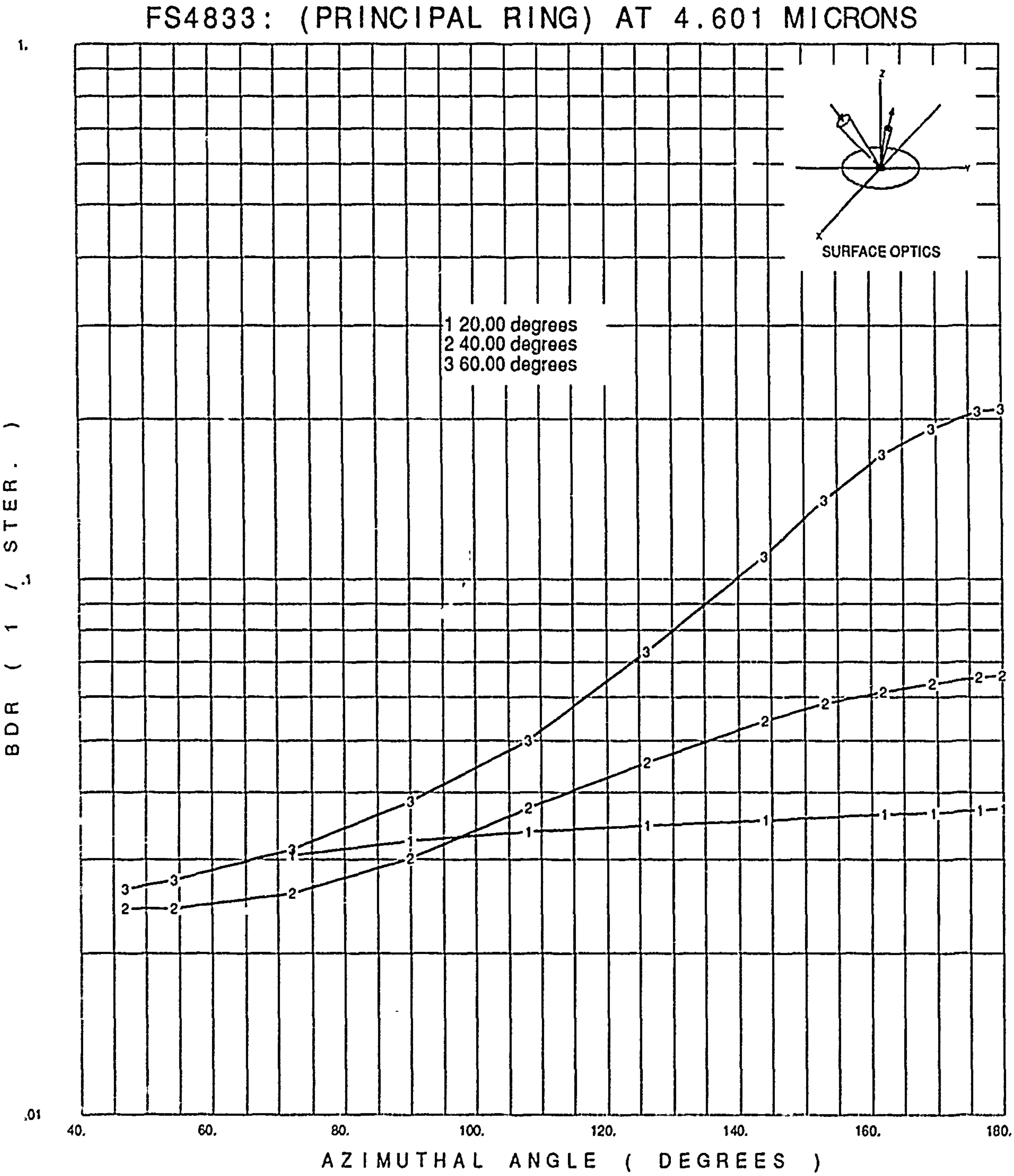

FIGURE A-17. SPECTRAL SCIENCES: BARK SAMPLE #1,
2PM, WEST SIDE, 55" UP, PHI = 0
BIDIRECTIONAL REFLECTANCE VS. REFLECTED AZIMUTH ANGLE
PRINCIPAL RING AT 4.601 MICROMETERS
INCIDENT POLAR ANGLES 20, 40 AND 60 DEGREES

APPENDIX A

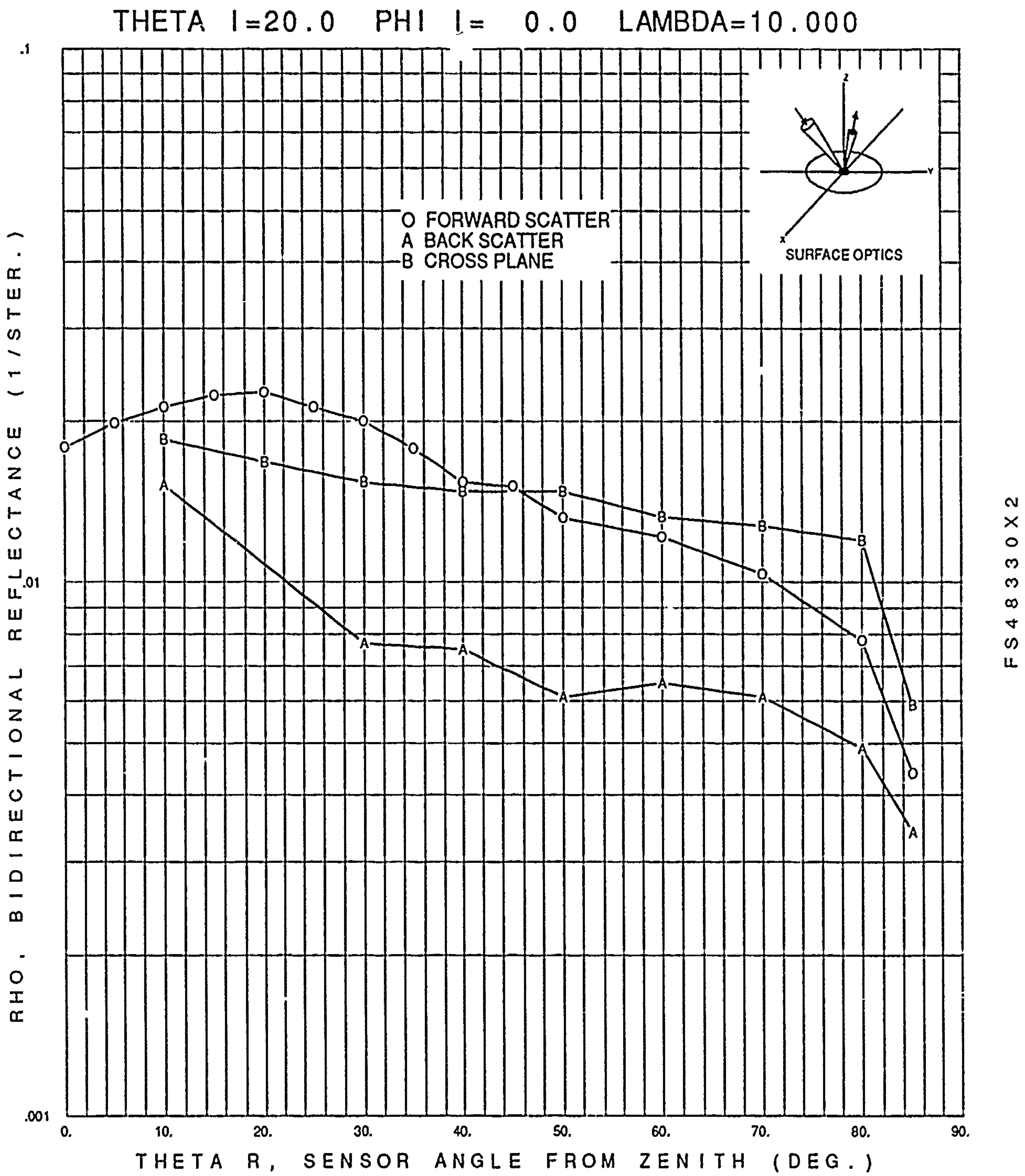

FIGURE A-18. SPECTRAL SCIENCES: BARK SAMPLE #1,
2PM, WEST SIDE, 55" UP
BIDIRECTIONAL REFLECTANCE VS. REFLECTED POLAR ANGLE
WAVELENGTH 10.000 MICROMETERS
INCIDENT POLAR ANGLE 20.0 DEGREES

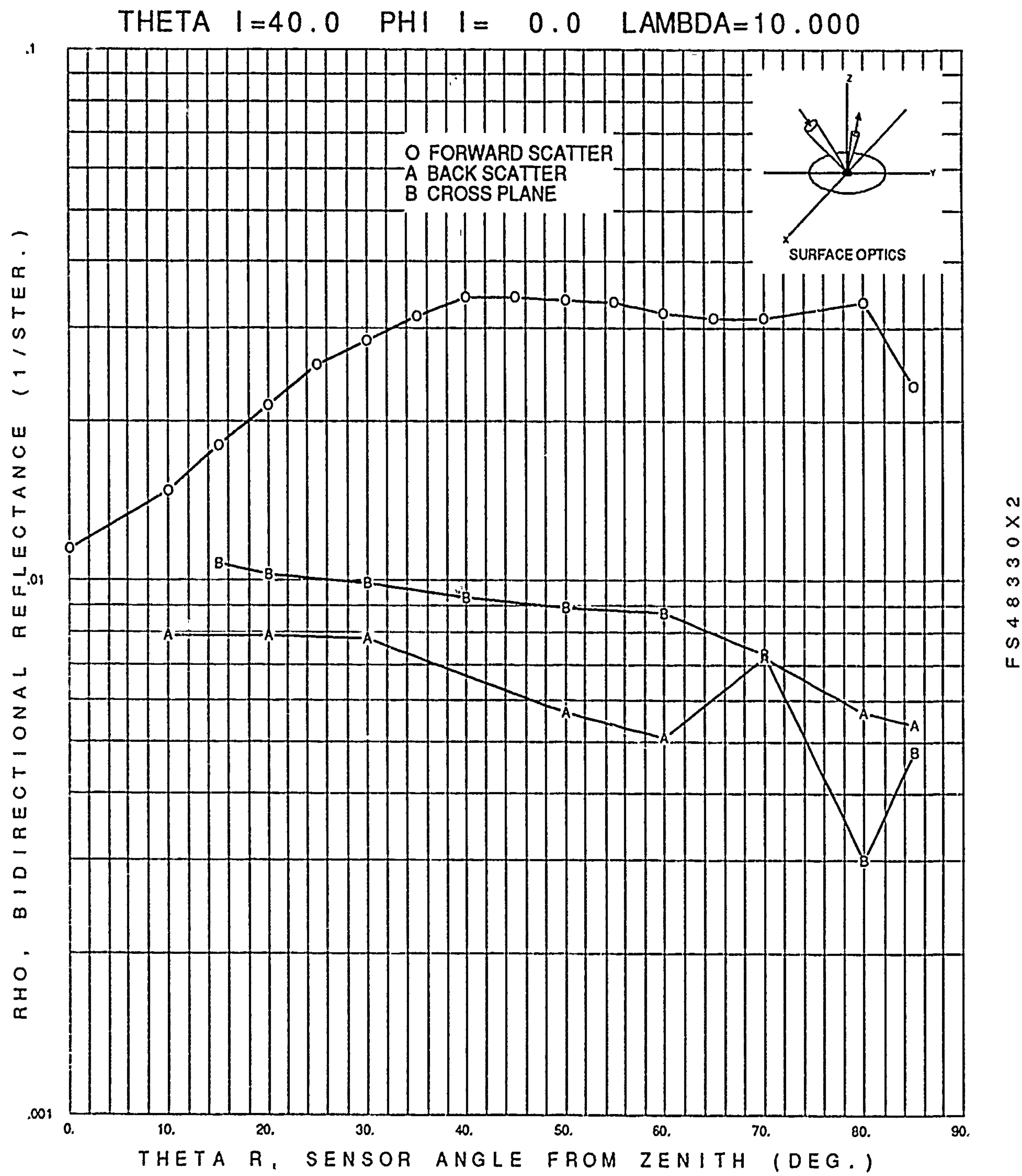

FIGURE A-19. SPECTRAL SCIENCES: BARK SAMPLE #1, 2PM, WEST SIDE, 55" UP
BIDIRECTIONAL REFLECTANCE VS. REFLECTED POLAR ANGLE
WAVELENGTH 10.000 MICROMETERS
INCIDENT POLAR ANGLE 40.0 DEGREES

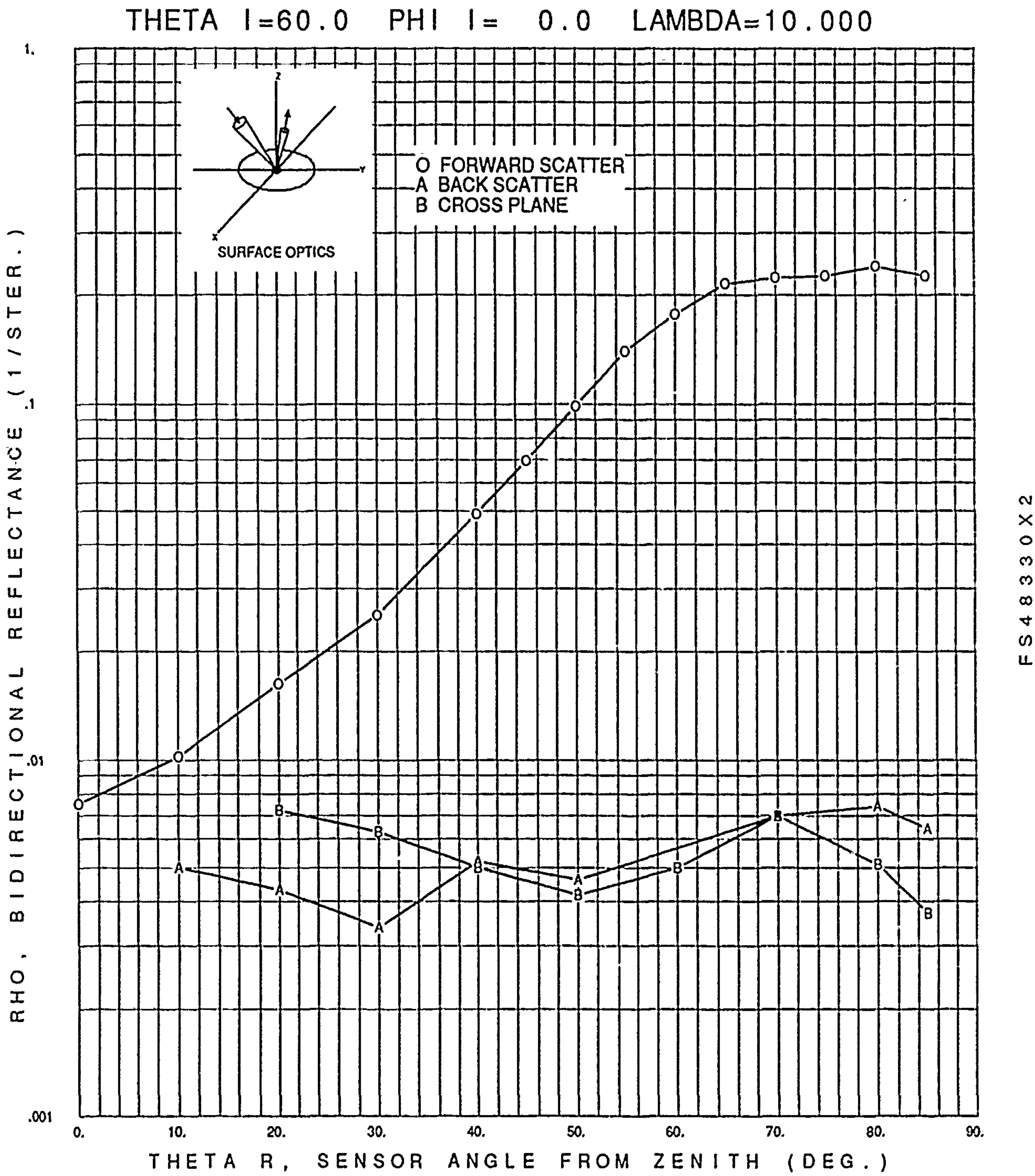

FIGURE A-20. SPECTRAL SCIENCES: BARK SAMPLE #1,
2PM. WEST SIDE, 55" UP
BIDIRECTIONAL REFLECTANCE VS. REFLECTED POLAR ANGLE
WAVELENGTH 10.000 MICROMETERS
INCIDENT POLAR ANGLE 60.0 DEGREES

APPENDIX A

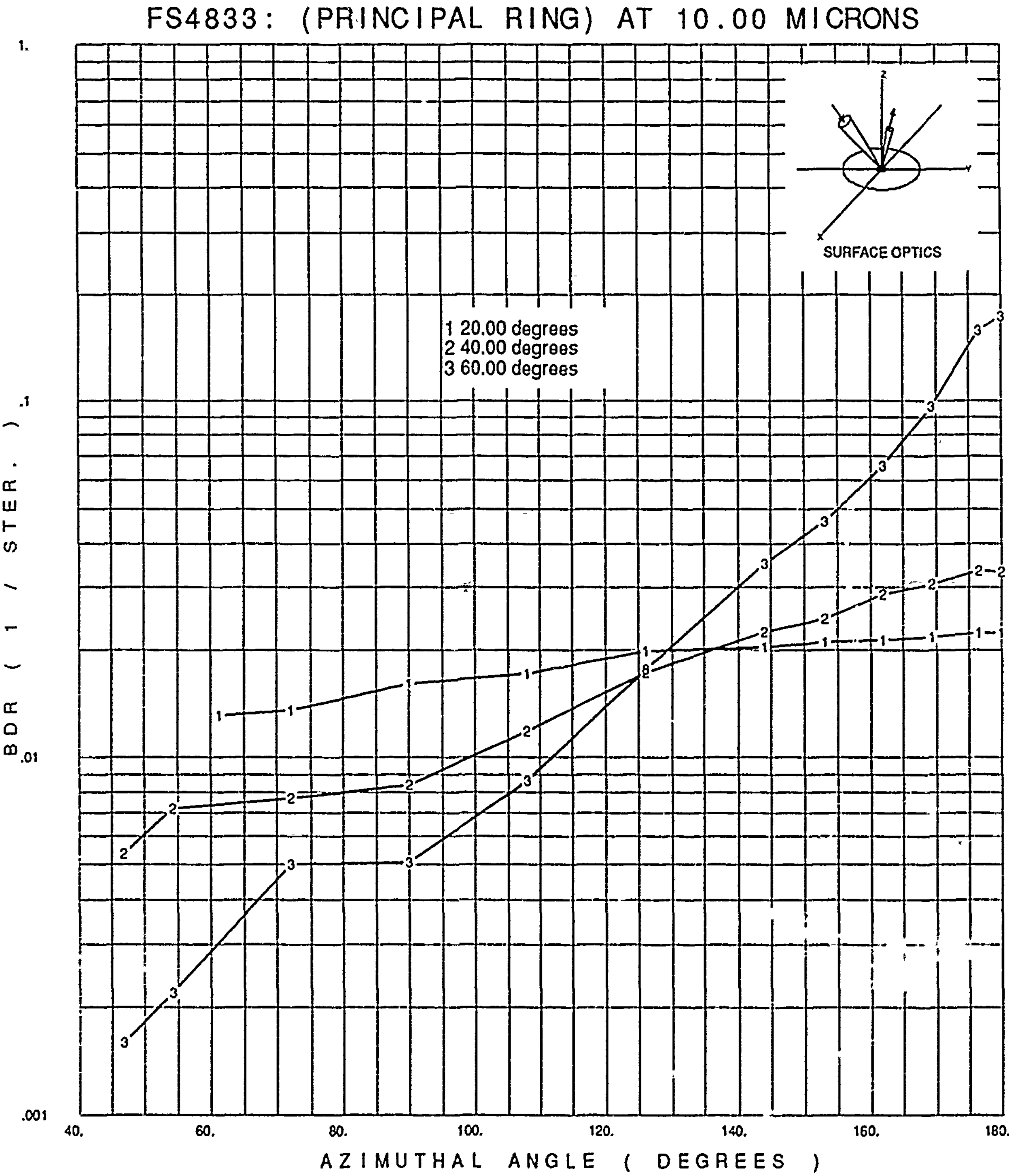

FIGURE A-21. SPECTRAL SCIENCES: BARK SAMPLE #1, 2PM, WEST SIDE, 55" UP. PHI = 0
BIDIRECTIONAL REFLECTANCE VS. REFLECTED AZIMUTH ANGLE
PRINCIPAL RING AT 10.00 MICROMETERS
INCIDENT POLAR ANGLES 20, 40 AND 60 DEGREES

APPENDIX A

TABLE A-6. SPECTRAL SCIENCES: BARK SAMPLE #1,
2PM, WEST SIDE, 55" UP. PHI = 0
BIDIRECTIONAL REFLECTANCE VS. REFLECTED POLAR ANGLE
ERAS DATA
WAVELENGTH 1.307, 4.601, 10 MICROMETERS
INCIDENT POLAR ANGLES 20, 40, 60 DEGREES

FS48330X25001		36	013								
FS48330X25101		SPECTRAL SCIENCES: BARK SAMPLE #1, 2PM, WEST SIDE, 55" UP									
FS48330X27004						760.					
FS48330X29001	1		4 10	0.0	85.0	14	1.307	20	0.0		180.0
FS48330X29201	1	0.0	.1774	5.0	.1776	10.0	.1785	15.	.1789	20.0	.1803
FS48330X29202	1	25.0	.1801	30.0	.1776	35.0	.1768	40.0	.1752	50.0	.1742
FS48330X29203	1	60.0	.1716	70.0	.166	80.0	.1599	85.0	.1164		
FS48330X29001	2		4 10	10.0	85.0	8	1.307	20.0	0.0		0.0
FS48330X29201	2	10.0	.1785	30.0	.1665	40.0	.171	50.0	.1694	60.0	.1669
FS48330X29202	2	70.0	.1613	80.0	.1804	85.0	.2083				
FS48330X29001	3		4 10	10.0	85.0	9	1.307	20.0	0.0		90.0
FS48330X29201	3	10.0	.1455	20.0	.1828	30.0	.1825	40.0	.1821	50.0	.1813
FS48330X29202	3	60.0	.1765	70.0	.1806	80.0	.1958	85.0	.2103		
FS48330X29001	4		5 10	64.8	180.0	11	1.307	20.0	0.0	20.0	
FS48330X29201	4	64.8	.1841	72.0	.1833	90.0	.1805	108.0	.1773	126.0	.1739
FS48330X29202	4	144.0	.1714	153.0	.1718	162.0	.1746	169.2	.1769	176.4	.1799
FS48330X29203	4	180.0	.1795								
FS48330X29001	5		4 10	0.0	85.0	14	1.307	40.0	0.0		180.0
FS48330X29201	5	0.0	.1714	10.0	.1749	20.0	.1803	25.0	.1848	30.0	.187
FS48330X29202	5	35.0	.1914	40.0	.1944	45.0	.1991	50.0	.2024	55.0	.2055
FS48330X29203	5	60.0	.2131	70.0	.2189	80.0	.1836	85.0	.1628		
FS48330X29001	6		4 10	10.0	85.0	8	1.307	40.0	0.0		0.0
FS48330X29201	6	10.0	.1687	20.0	.1691	30.0	.1671	50.0	.1651	60.0	.1594
FS48330X29202	6	70.0	.1653	80.0	.176	85.0	.1753				
FS48330X29001	7		4 10	15.0	85.0	9	1.307	40.0	0.0		90.0
FS48330X29201	7	15.0	.1747	20.0	.1735	30.0	.1734	40.0	.1721	50.0	.1742
FS48330X29202	7	60.0	.1716	70.0	.1781	80.0	.1823	85.0	.2355		
FS48330X29001	8		5 10	46.8	180.0	12	1.307	40.0	0.0	40.0	
FS48330X29201	8	46.8	.1741	54.0	.1787	72.0	.1744	90.0	.1718	108.0	.1681
FS48330X29202	8	126.0	.1684	144.0	.1744	153.0	.1787	162.0	.183	169.2	.1887
FS48330X29203	8	176.4	.1946	180.0	.1938						
FS48330X29001	9		4 10	0.0	85.0	14	1.307	60.0	0.0		180.0
FS48330X29201	9	0.0	.1579	10.0	.163	20.0	.173	30.0	.1846	40.0	.2056
FS48330X29202	9	45.0	.2162	50.0	.231	55.0	.2443	60.0	.2743	65.0	.2825
FS48330X29203	9	70.0	.2953	75.0	.3037	80.0	.2966	85.0	.2187		
FS48330X29001	10		4 10	10.0	85.0	8	1.307	60.0	0.0		0.0
FS48330X29201	10	10.0	.1552	20.0	.1545	30.0	.1549	40.0	.1594	50.0	.1691
FS48330X29202	10	70.0	.1799	80.0	.2273	85.0	.3108				
FS48330X29001	11		4 10	20.0	85.0	8	1.307	60.0	0.0		90.0
FS48330X29201	11	20.0	.1434	30.0	.1464	40.0	.145	50.0	.1488	60.0	.1472
FS48330X29202	11	70.0	.1428	80.0	.1618	85.0	.1804				
FS48330X29001	12		5 10	46.8	180.0	12	1.307	60.0	0.0	60.0	
FS48330X29201	12	46.8	.1545	54.0	.1692	72.0	.1579	90.0	.1472	108.0	.1425
FS48330X29202	12	126.0	.1465	144.0	.1612	153.0	.1779	162.0	.204	169.2	.2308
FS48330X29203	12	176.4	.2509	180.0	.2616						
FS48330X29001	13		4 10	0.0	85.0	14	4.601	20.0	0.0		180.0
FS48330X29201	13	0.0	.0326	5.0	.0336	10.0	.0346	15.0	.0357	20.0	.0369
FS48330X29202	13	25.0	.0368	30.0	.0375	35.0	.0375	40.0	.0382	50.0	.0384

APPENDIX A

TABLE A-6. (CONTINUED)

FS48330X29203	13	60.0	.0395	70.0	.041	80.0	.0387	85.0	.0268		
FS48330X29001	14		4 10	10.0	85.0	8	4.601	20.0	0.0		0.0
FS48330X29201	14	10.0	.031	30.0	.0235	40.0	.0214	50.0	.0225	60.0	.0225
FS48330X29202	14	70.0	.0218	80.0	.021	85.0	.0218				
FS48330X29001	15		4 10	10.0	85.0	9	4.601	20.0	0.0		90.[illegible]
FS48330X29201	15	10.0	.0315	20.0	.0305	30.0	.0306	40.0	.0313	50.0	.0334
FS48330X29202	15	60.0	.0345	70.0	.035	80.0	.0362	85.0	.0386		
FS48330X29001	16		5 10	72.0	180.0	9	4.601	20.0	0.0	20.0	
FS48330X29201	16	72.0	.0306	90.0	.0324	108.0	.0339	126.0	.0348	144.0	.0356
FS48330X29202	16	162.0	.0364	169.2	.0366	176.4	.0372	180.0	.0373		
FS48330X29001	17		4 10	0.0	85.0	14	4.601	40.0	0.0		180.0
FS48330X29201	17	0.0	.0269	10.0	.0322	20.0	.0406	25.0	.0457	30.0	.0522
FS48330X29202	17	35.0	.0578	40.0	.0653	45.0	.07	50.0	.0759	55.0	.0807
FS48330X29203	17	60.0	.0853	70.0	.0954	80.0	.0888	85.0	.0741		
FS48330X29001	18		4 10	10.0	85.0	8	4.601	40.0	0.0		0.0
FS48330X29201	18	10.0	.024	20.0	.02[illegible]5	30.0	.0248	50.0	.0229	60.0	.0233
FS48330X29202	18	70.0	.0252	80.0	.0268	85.0	.0206				
FS48330X29001	19		4 10	15.0	85.0	9	4.601	40.0	0.0		90.0
FS48330X29201	19	15.0	.0271	20.0	.0273	30.0	.029	40.0	.0309	50.0	.0329
FS48330X29202	19	60.0	.0348	70.0	.0357	80.0	.0392	85.0	.0329		
FS48330X29001	20		5 10	46.8	180.0	12	4.[illegible]1	40.0	0.0	40.0	
FS48330X29201	20	46.8	.0243	54.0	.0243	72.0	.[illegible]26	90.0	.0302	108.0	.0375
FS48330X29202	20	126.0	.0456	144.0	.0543	153.0	.0585	162.0	.0616	169.2	.0637
FS48330X29203	20	176.4	.0653	180.0	.066						
FS48330X29001	21		4 10	0.0	85.0	14	4.601	60.0	0.0		180.0
FS48330X29201	21	0.0	.0247	10.0	.0318	20.0	.0415	30.0	.0615	40.0	.0936
FS48330X29202	21	45.0	.115	50.0	.141	55.0	.1724	60.0	.206	65.0	.247
FS48330X29203	21	70.0	.2843	75.0	.312	80.0	.3164	85.0	.312		
FS48330X29001	22		4 10	10.0	85.0	8	4.601	60.0	0.0		0.0
FS48330X29201	22	10.0	.022[illegible]	20.0	.0196	30.0	.0222	40.0	.0237	50.0	.0274
FS48330X29202	22	70.0	.03[illegible]3	80.0	.0396	85.0	.0441				
FS48330X29001	23		4 10	20.0	85.0	8	4.601	60.0	0.0		90.0
FS48330X29201	23	20.0	.0266	30.0	.0292	40.0	.0316	50.0	.0342	60.0	.0379
FS48330X29202	23	70.0	.0386	80.0	.0396	85.0	.03[illegible]5				
FS48330X29001	24		5 10	46.8	180.0	12	4.601	60.0	0.0	60.0	
FS48330X29201	24	46.8	.0264	54.0	.0275	72.0	.0313	90.0	.0385	108.0	.05
FS48330X29202	24	126.0	.0731	144.0	.1104	153.0	.1406	162.0	.1714	169.2	.1917
FS48330X29203	24	176.4	.206	180.0	.2077						
FS48330X29001	25		4 10	0.0	85.0	15	10.000	20.0	0.0		180.0
FS48330X29201	25	0.0	.0179	5.0	.0198	10.0	.0213	15.0	.0224	20.0	.0228
FS48330X29202	25	25.0	.0213	30.0	.02	35.0	.0178	40.0	.0154	45.0	.0151
FS48330X29203	25	50.0	.0132	60.0	.0121	70.0	.0104	80.0	.0078	85.0	.0044
FS48330X29001	26		4 10	10.0	85.0	8	10.000	20.0	0.0		0.0
FS48330X29201	26	10.0	.0152	30.0	.0077	40.0	.0075	50.0	.0061	60.0	.0065
FS48330X29202	26	70.0	.0061	80.0	.0049	85.0	.0034				
FS48330X29001	27		4 10	10.0	85.0	9	10.000	20.0	0.0		90.0
FS48330X29201	27	10.0	.0185	20.0	.0168	30.0	.0154	40.0	.0148	50.0	.0148
FS48330X29202	27	60.0	.0133	70.0	.0127	80.0	.012	85.0	.0059		

APPENDIX A

TABLE A-6. (CONTINUED)

FS48330X29001	28		5 10	61.2	180.0	11	10.000	20.0	0.0	20.0	
FS48330X29201	28	61.2	.0131	72.0	.0135	90.0	.0161	108.0	.0172	126.0	.0198
FS48330X29202	28	144.0	.0204	153.0	.021	162.0	.0213	169.2	.0218	176.4	.0223
FS48330X29203	28	180.0	.0223								
FS48330X29001	29		4 10	0.0	85.0	16	10.000	40.0	0.0		180.0
FS48330X29201	29	0.0	.0115	10.0	.0148	15.0	.018	20.0	.0215	25.0	.0255
FS48330X29202	29	30.0	.0284	35.0	.0316	40.0	.0342	45.0	.0342	50.0	.034
FS48330X29203	29	55.0	.0337	60.0	.0321	65.0	.0313	70.0	.0313	80.0	.0336
FS48330X29204	29	85.0	.0233								
FS48330X29001	30		4 10	10.0	85.0	8	10.000	40.0	0.0		0.0
FS48330X29201	30	10.0	.0079	20.0	.0079	30.0	.0078	50.0	.0057	60.0	.0051
FS48330X29202	30	70.0	.0072	80.0	.0057	85.0	.0054				
FS48330X29001	31		4 10	15.0	85.0	9	10.000	40.0	0.0		90.0
FS48330X29201	31	15.0	.0108	20.0	.0103	30.0	.0099	40.0	.0093	50.0	.0089
FS48330X29202	31	60.0	.0087	70.0	.0073	80.0	.003	85.0	.0048		
FS48330X29001	32		5 10	46.8	180.0	12	10.000	40.0	0.0	40.0	
FS48330X29201	32	46.8	.0054	54.0	.0072	72.0	.0077	90.0	.0084	108.0	.0118
FS48330X29202	32	126.0	.0173	144.0	.0224	153.0	.0245	162.0	.0287	169.2	.0308
FS48330X29203	32	176.4	.0334	180.0	.0333						
FS48330X29001	33		4 10	0.0	85.0	14	10.000	60.0	0.0		180.0
FS48330X29201	33	0.0	.0075	10.0	.0102	20.0	.0162	30.0	.0253	40.0	.0486
FS48330X29202	33	45.0	.0694	50.0	.098	55.0	.1399	60.0	.177	65.0	.216
FS48330X29203	33	70.0	.2258	75.0	.229	80.0	.2415	85.0	.2282		
FS48330X29001	34		4 10	10.0	85.0	8	10.000	60.0	0.0		0.0
FS48330X29201	34	10.0	.005	20.0	.0043	30.0	.0034	40.0	.0052	50.0	.0046
FS48330X29202	34	70.0	.007	80.0	.0074	85.0	.0064				
FS48330X29001	35		4 10	20.0	85.0	8	10.000	60.0	0.0		90.0
FS48330X29201	35	20.0	.0072	30.0	.0063	40.0	.005	50.0	.0042	60.0	.005
FS48330X29202	35	70.0	.007	80.0	.0051	85.0	.0037				
FS48330X29001	36		5 10	46.8	180.0	12	10.000	60.0	0.0	60.0	
FS48330X29201	36	46.8	.0016	54.0	.0022	72.0	.005	90.0	.0051	108.0	.0086
FS48330X29202	36	126.0	.0177	144.0	.035	153.0	.0462	162.0	.066	169.2	.0965
FS48330X29203	36	176.4	.1577	180.0	.1738						

APPENDIX A

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APPENDIX B

SPECTRAL SCIENCES INC.
BARK SAMPLE #2, 2:16 PM,
NORTH-EAST SIDE, 51 INCHES UP.
FS4834:

INDEX TO APPENDIX B

PAGE NO.

DIRECTIONAL REFLECTANCE

INDEX TO APPENDIX B (continued)

INDEX TO APPENDIX B (continued)

PAGE NO.

BIDIRECTIONAL REFLECTANCE

APPENDIX B

INDEX TO APPENDIX B (continued)

PAGE NO.

BIDIRECTIONAL REFLECTANCE

APPENDIX B

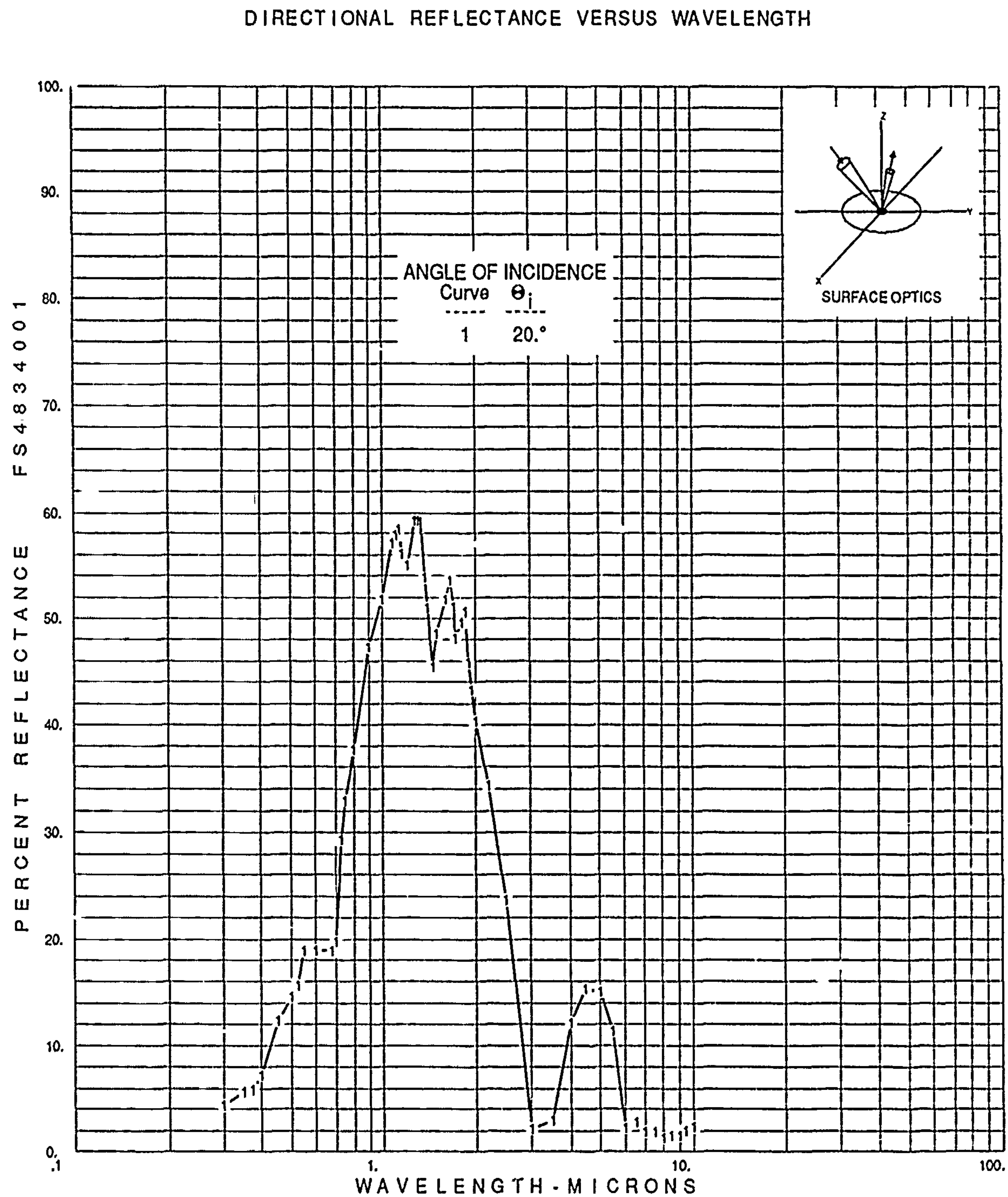


FIGURE B-1. SPECTRAL SCIENCES: BARK SAMPLE #2,
2:16PM, NORTH-EAST SIDE, 51" UP.
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 10.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX B

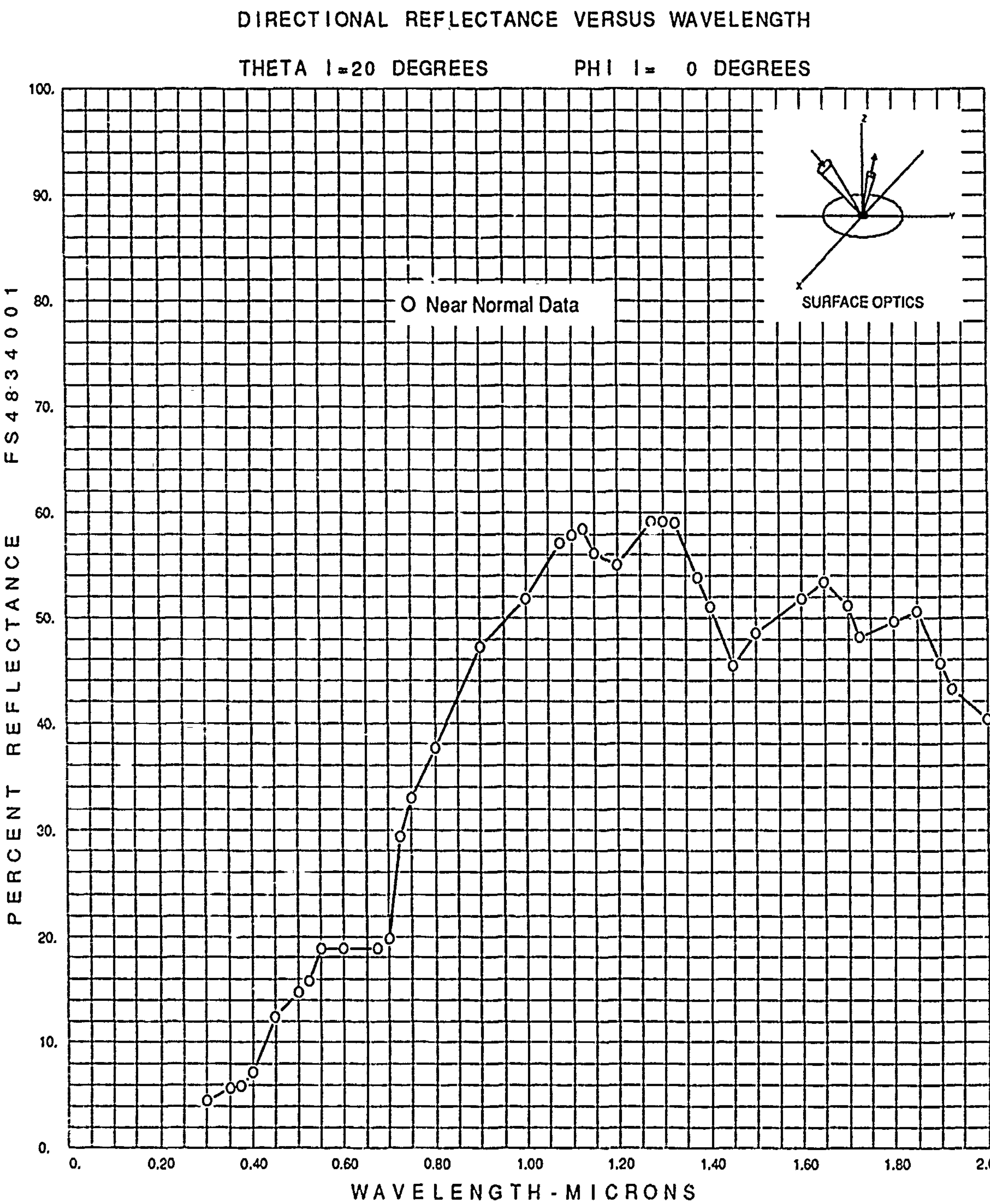


FIGURE B-2. SPECTRAL SCIENCES: BARK SAMPLE #2, 2:16PM, NORTH-EAST SIDE, 51" UP. DIRECTIONAL REFLECTANCE VS. WAVELENGTH BANDWIDTH 0.3 TO 2.0 MICROMETERS DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX B

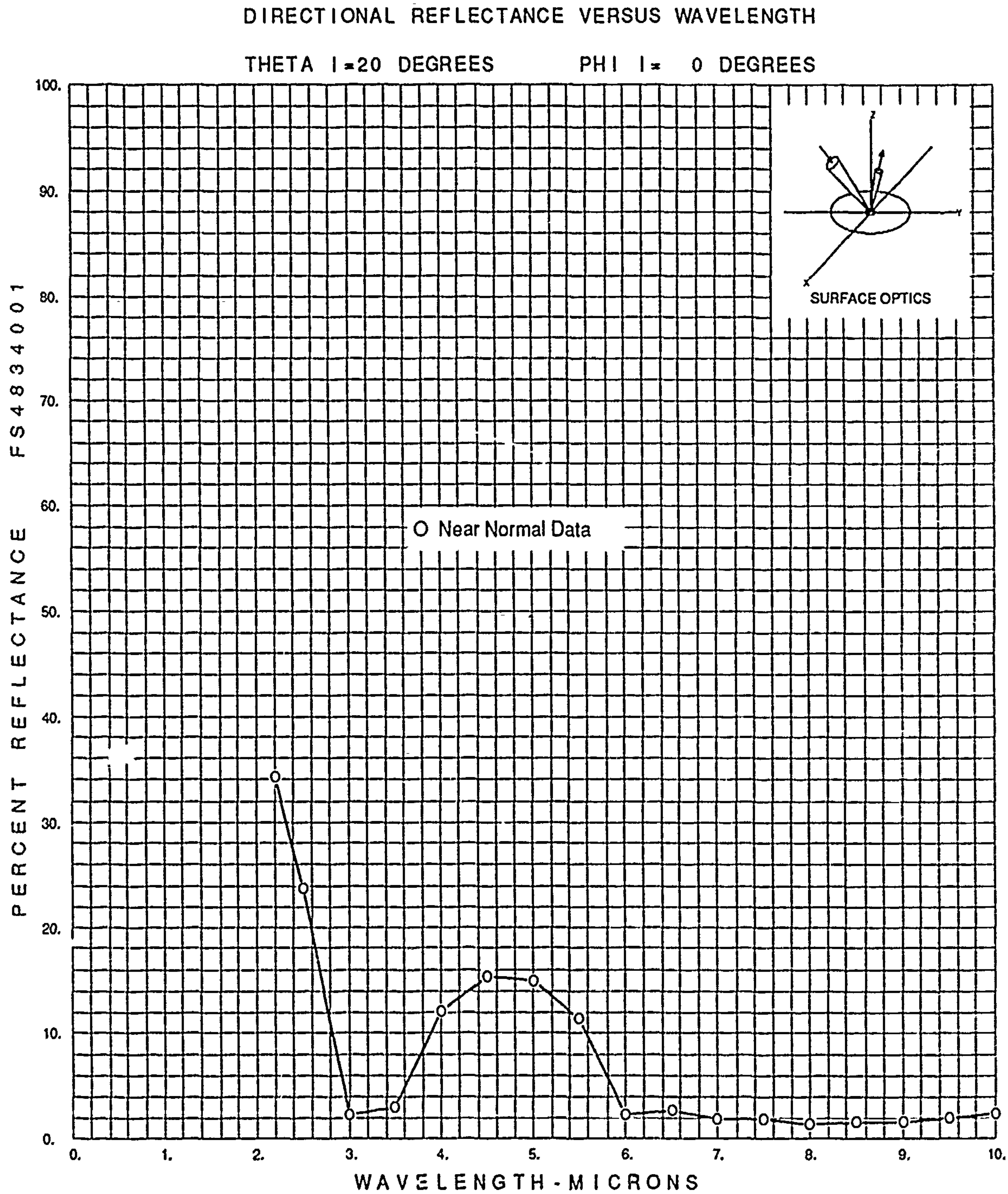


FIGURE B-3. SPECTRAL SCIENCES: BARK SAMPLE #2, 2:16PM, NORTH-EAST SIDE, 51" UP. DIRECTIONAL REFLECTANCE VS. WAVELENGTH BANDWIDTH 2.2 TO 10.0 MICROMETERS DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX B

TABLE B-1. SPECTRAL SCIENCES: BARK SAMPLE #2, 2:16PM, NORTH-EAST SIDE, 51" UP. PHI = 0 DIRECTIONAL REFLECTANCE VS. WAVELENGTH - ERAS DATA DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

```
FS48340015001            1      1
FS48340015101       SPECTRAL SCIENCES: BARK SAMPLE #2, 2:16PM, NORTH-EAST SIDE,
FS48340015102       51" UP. PHI = 0
FS48340015103       UNCORRECTED FOR INSTRUMENTATION POLARIZATION EFFECTS
FS48340017001       091390
FS48340019001   1       001  1      .3     10.  54                            20.       0.
FS48340019201   1      .3    4.4   .35     5.7  .375    5.9     .4    7.2    .45     12.3
FS48340019202   1      .5   14.6  .525    15.7   .55   18.9     .6   18.9   .675     18.9
FS48340019203   1      .7   19.8  .725    29.3   .75   32.9     .8   37.7     .9     47.2
FS48340019204   1      1.   51.8 1.075    57.1   1.1   57.8  1.125   58.4   1.15     56.1
FS48340019205   1     1.2   55.0 1.275    59.2   1.3   59.2  1.325   59.1  1.375     53.8
FS48340019206   1     1.4   51.0  1.45    45.4   1.5   48.5    1.6   51.8   1.65     53.5
FS48340019207   1     1.7   51.1 1.725    48.1   1.8   49.6   1.85   50.6    1.9     45.7
FS48340019208   1   1.925   43.3    2.    40.3   2.2   34.3    2.5   23.7     3.      2.2
FS48340019209   1     3.5    3.0    4.    12.1   4.5   15.4     5.   15.0    5.5     11.4
FS48340019210   1      6.    2.3   6.5     2.7    7.    1.9    7.5    1.9     8.      1.4
FS48340019211   1     8.5    1.6    9.     1.6   9.5    2.0    10.    2.4
```

APPENDIX B

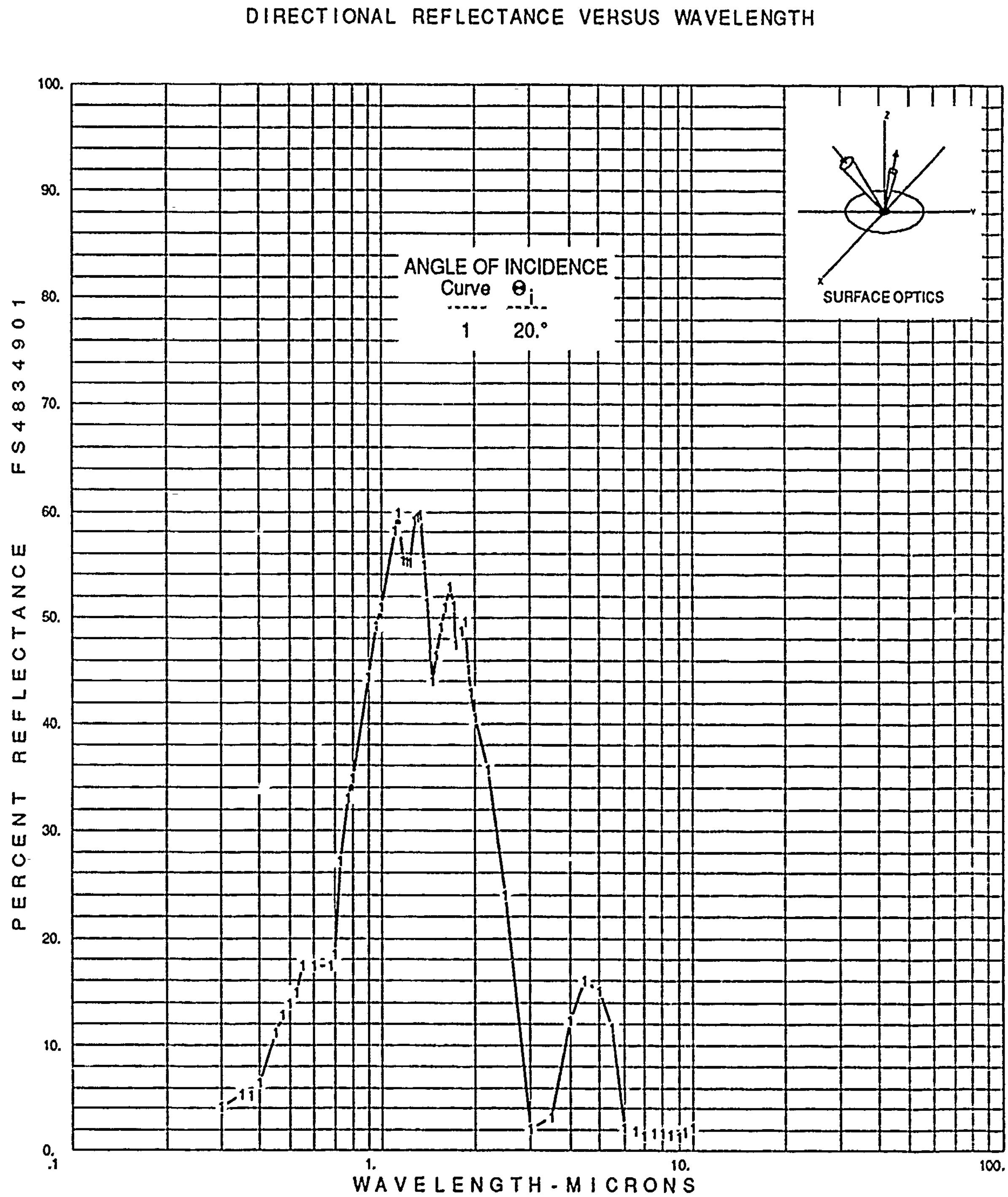


FIGURE B-4. SPECTRAL SCIENCES: BARK SAMPLE #2,
2:16PM, NORTH-EAST SIDE, 51" UP.
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 10.0 MICROMETERS. PHI = 90
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX B

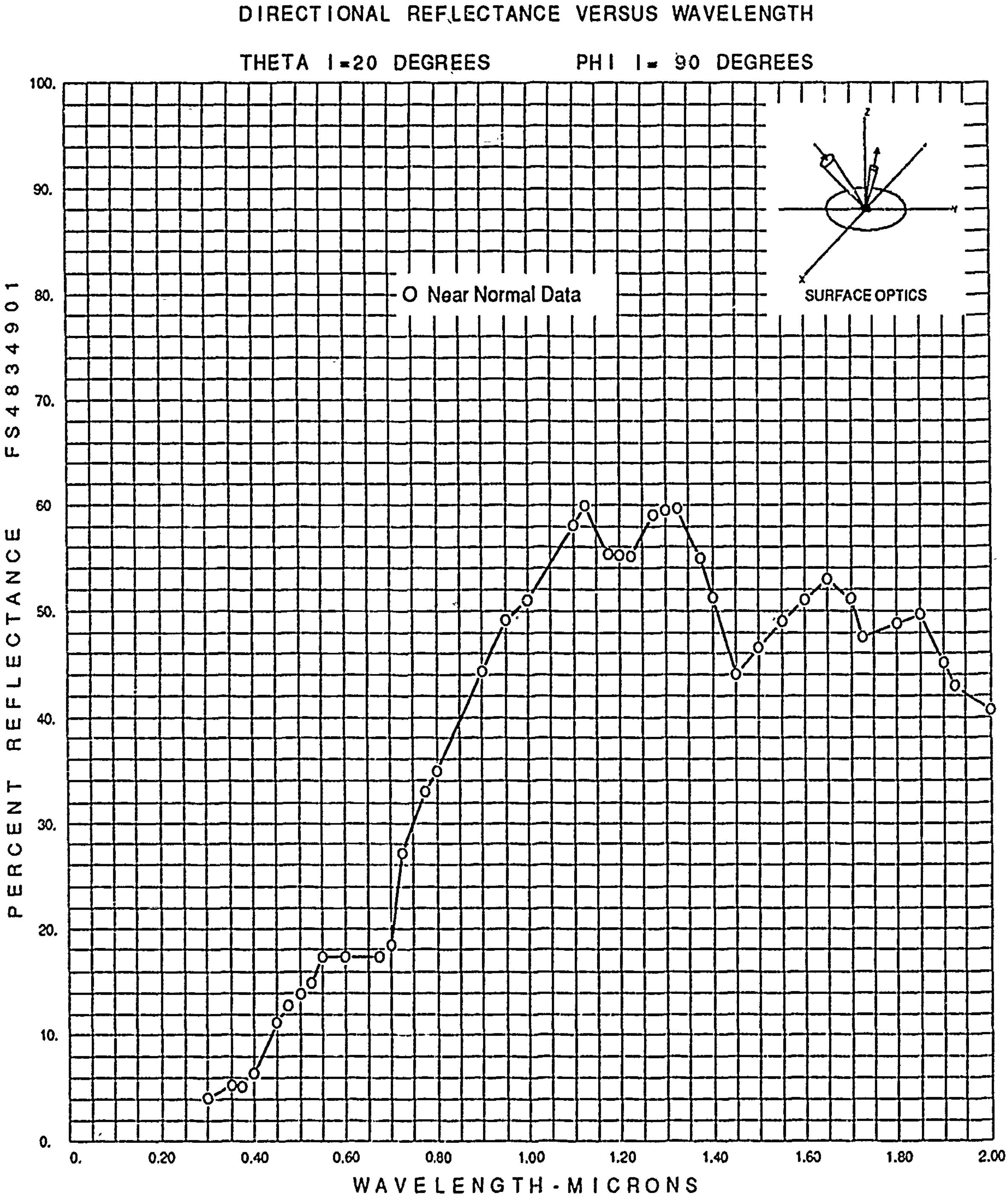


FIGURE B-5. SPECTRAL SCIENCES: BARK SAMPLE #2,
2:16PM. NORTH-EAST SIDE. 51" UP.
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 2.0 MICROMETERS. PHI = 90
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX B

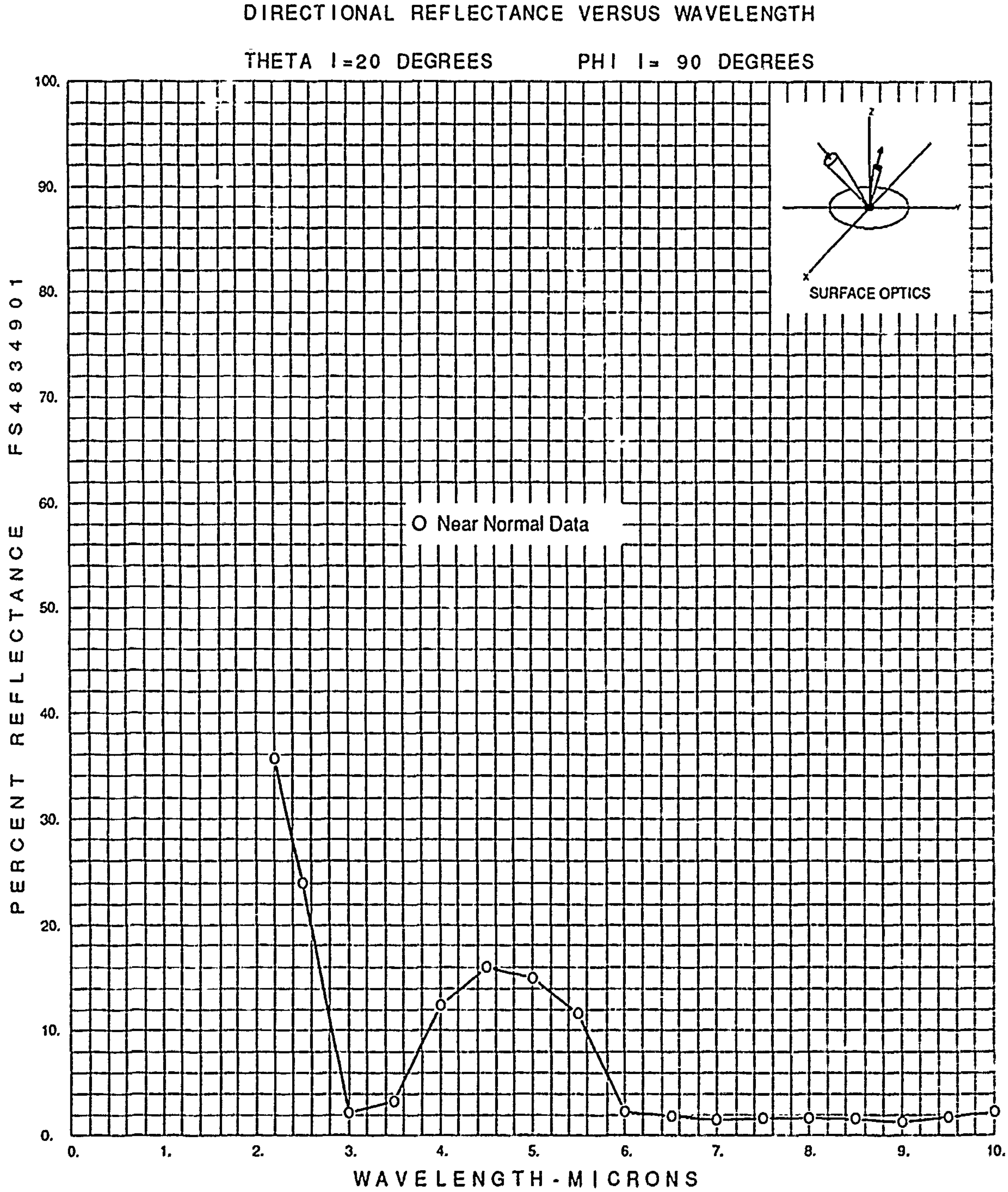


FIGURE B-6. SPECTRAL SCIENCES: BARK SAMPLE #2,
2:16PM, NORTH-EAST SIDE, 51" UP.
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 2.2 TO 10.0 MICROMETERS. PHI = 90
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX B

TABLE B-2. SPECTRAL SCIENCES: BARK SAMPLE #2, 2:16PM, NORTH-EAST SIDE, 51" UP. PHI = 90
DIRECTIONAL REFLECTANCE VS. WAVELENGTH - ERAS DATA
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

```
FS48349015001            1       1
FS48349015101       SPECTRAL SCIENCES: BARK SAMPLE #2, 2:16PM, NORTH-EAST SIDE,
FS48349015102       51" UP. PHI = 90
FS48349015103       UNCORRECTED FOR INSTRUMENTATION POLARIZATION EFFECTS
FS48349017001       092090
FS48349019001   1        001  1     .3    10.  57                        20.    90.
FS48349019201   1      .3   4.1    .35   5.3  .375   5.2     .4   6.4   .45   11.1
FS48349019202   1    .475  12.8     .5  13.9  .525  14.9    .55  17.4    .6   17.4
FS48349019203   1    .675  17.4     .7  18.5  .725  27.1   .775  33.0    .8   34.9
FS48349019204   1      .9  44.4    .95  49.2    1.  51.0    1.1  58.1 1.125   59.9
FS48349019205   1   1.175  55.3    1.2  55.2 1.225  55.1  1.275  59.1   1.3   59.4
FS48349019206   1   1.325  59.6  1.375  54.9   1.4  51.3   1.45  44.0   1.5   46.5
FS48349019207   1    1.55  49.1    1.6  51.0  1.65  52.9    1.7  51.1 1.725   47.5
FS48349019208   1     1.8  48.8   1.85  49.6   1.9  45.1  1.925  42.9    2.   40.6
FS48349019209   1     2.2  35.7    2.5  24.0    3.   2.1    3.5   3.2    4.   12.3
FS48349019210   1     4.5  16.0     5.  15.0   5.5  11.6     6.   2.2   6.5    1.9
FS48349019211   1      7.   1.5    7.5   1.7    8.   1.7    8.5   1.6    9.    1.3
FS48349019212   1     9.5   1.8    10.   2.2
```

APPENDIX B

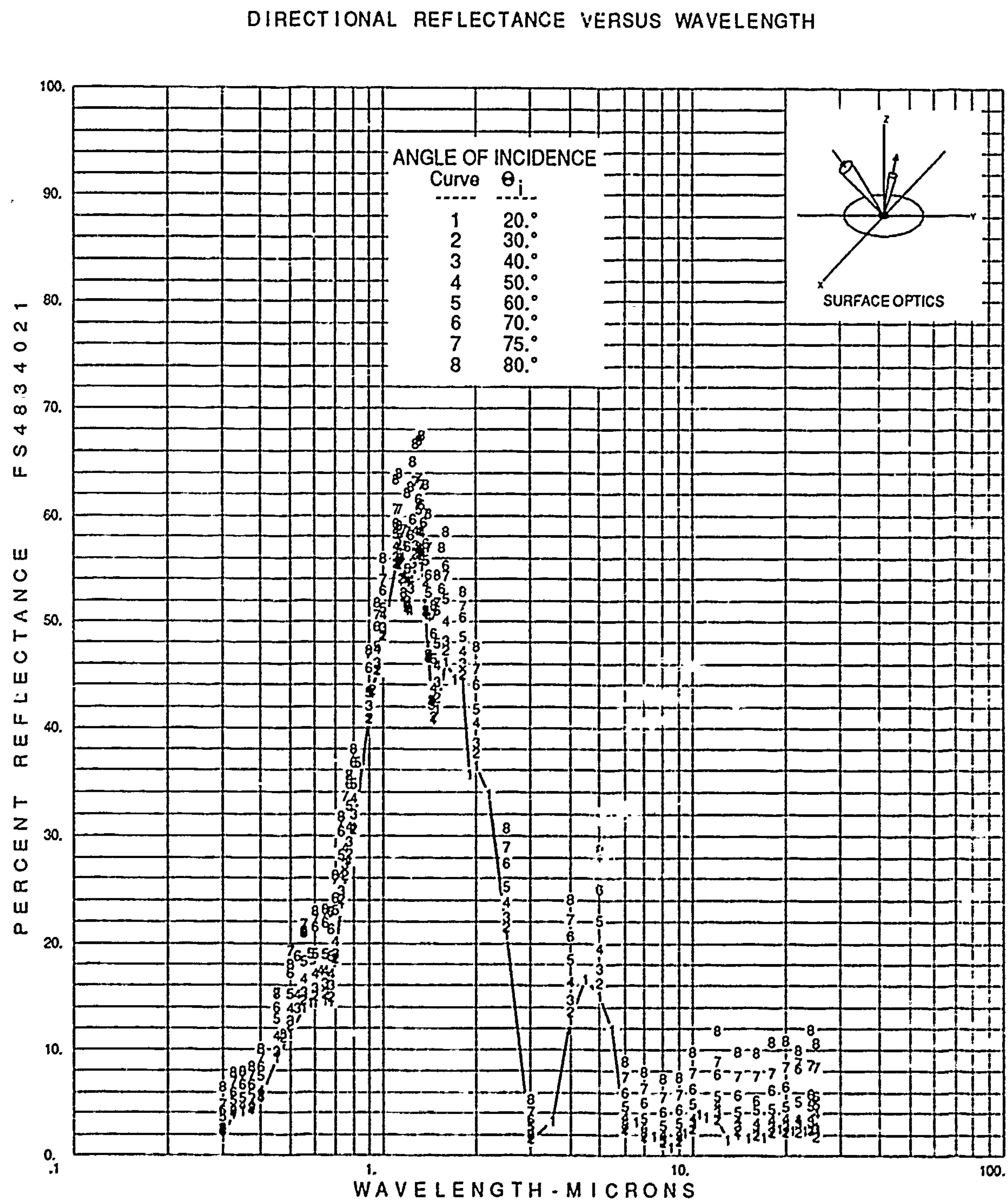


FIGURE B-7. SPECTRAL SCIENCES: BARK SAMPLE #2,
2:16PM, NORTH-EAST SIDE, 51" UP
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 25.0 MICROMETERS
DATA CORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX B

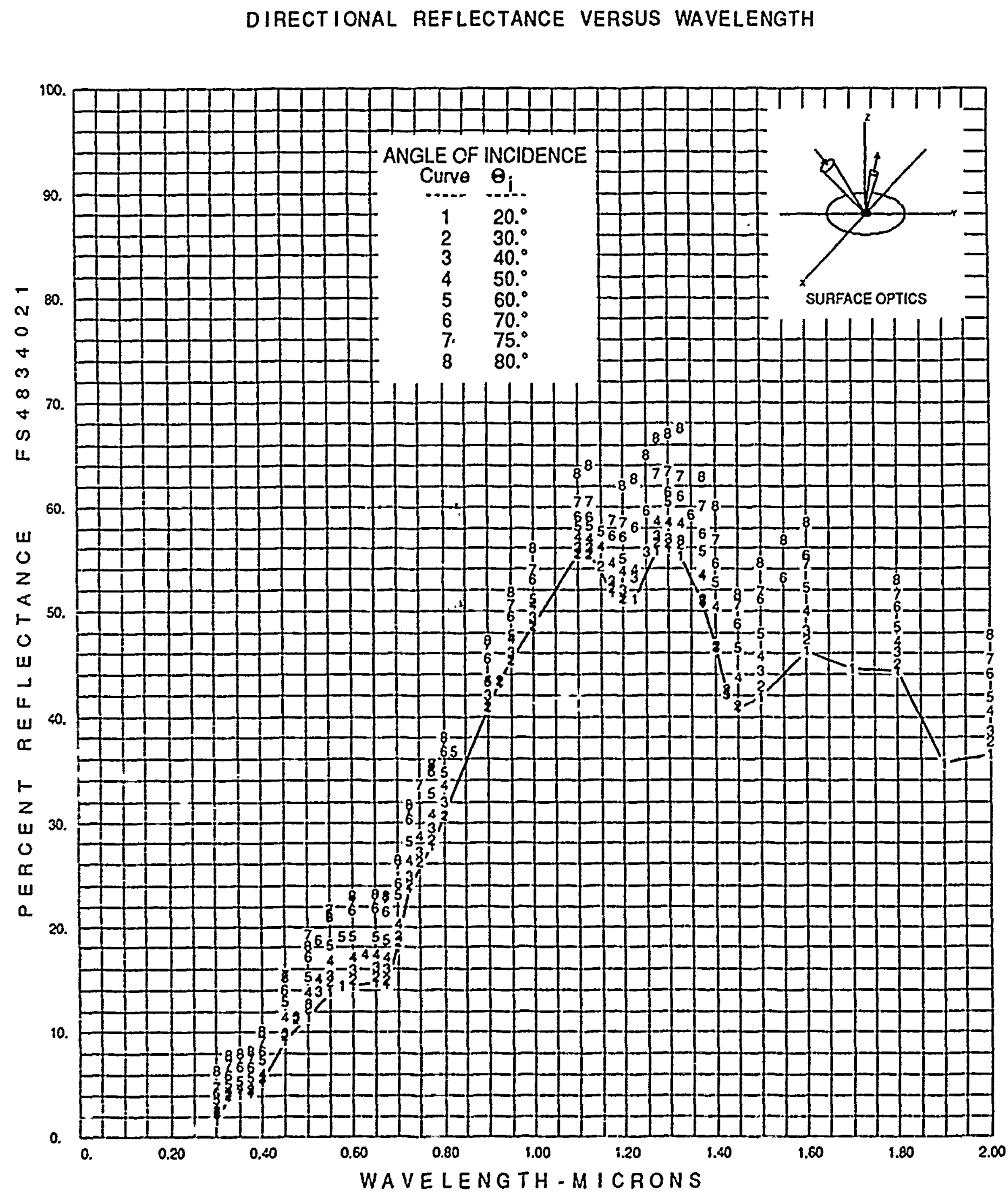


FIGURE B-8. SPECTRAL SCIENCES: BARK SAMPLE #2, 2:16PM, NORTH-EAST SIDE, 51" UP DIRECTIONAL REFLECTANCE VS. WAVELENGTH BANDWIDTH 0.3 TO 2.0 MICROMETERS DATA CORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX B

DIRECTIONAL REFLECTANCE VERSUS WAVELENGTH

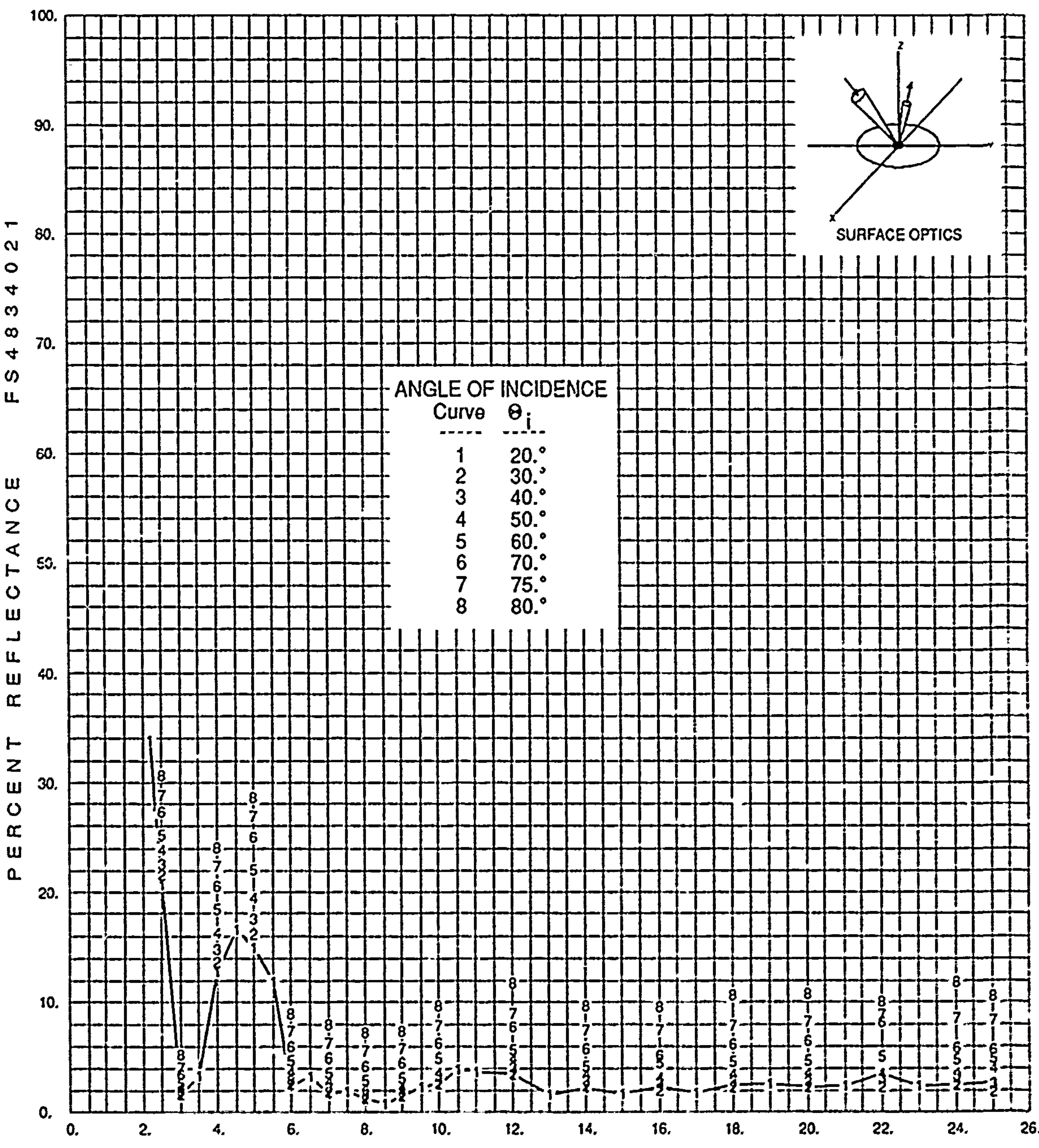


FIGURE B-9. SPECTRAL SCIENCES: BARK SAMPLE #2, 2:16PM, NORTH-EAST SIDE, 51" UP DIRECTIONAL REFLECTANCE VS. WAVELENGTH BANDWIDTH 2.2 TO 25.0 MICROMETERS DATA CORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX B

TABLE B-3. SPECTRAL SCIENCES: BARK SAMPLE #2, 2:16PM, NORTH-EAST SIDE, 51" UP. PHI = 0
DIRECTIONAL REFLECTANCE VS. WAVELENGTH - ERAS DATA
DATA CORRECTED FOR INSTRUMENTATION POLARIZATION

FS48340215001		8	1								
FS48340215101		SPECTRAL SCIENCES: BARK SAMPLE #2, 2:16PM, NORTH-EAST SIDE,									
FS48340215102		51" UP. PHI=0									
FS48340215103		CORRECTED FOR INSTRUMENTATION POLARIZATION EFFECTS									
FS48340217001		091690									
FS48340219001	1	001	1	.3	25.	71				20.	0.
FS48340219201	1	.3	1.7	.325	3.8	.35	4.1	.375	4.3	.4	5.4
FS48340219202	1	.45	9.2	.5	11.5	.55	13.8	.575	14.4	.6	14.4
FS48340219203	1	.65	14.6	.675	14.5	.7	18.5	.725	23.7	.775	27.8
FS48340219204	1	.8	30.7	.9	40.8	.925	43.3	.95	45.3	1.	48.6
FS48340219205	1	1.1	55.4	1.125	55.5	1.175	51.8	1.2	51.1	1.225	51.1
FS48340219206	1	1.275	55.8	1.3	56.0	1.325	55.2	1.375	50.7	1.4	46.7
FS48340219207	1	1.425	42.4	1.45	40.8	1.5	41.8	1.6	46.2	1.7	44.6
FS48340219208	1	1.8	44.3	1.9	35.7	2.	36.5	2.2	33.8	2.5	20.7
FS48340219209	1	3.	1.6	3.5	3.3	4.	12.8	4.5	16.6	5.	15.0
FS48340219210	1	5.5	11.9	6.	2.4	6.5	3.2	7.	1.7	7.5	1.9
FS48340219211	1	8.	1.3	8.5	0.8	9.	1.5	9.5	2.2	10.	2.6
FS48340219212	1	10.5	3.9	11.	3.7	12.	3.5	13.	1.6	14.	2.1
FS48340219213	1	15.	1.7	16.	2.2	17.	1.8	18.	2.5	19.	2.6
FS48340219214	1	20.	2.3	21.	2.4	22.	3.5	23.	2.4	24.	2.5
FS48340219215	1	25.	2.7								
FS48340219001	2	001	1	.3	25.	53				30.	0.
FS48340219201	2	.3	2.6	.325	4.1	.375	4.5	.4	5.8	.45	9.7
FS48340219202	2	.475	11.2	.5	12.3	.55	14.7	.6	15.0	.65	15.3
FS48340219203	2	.675	14.9	.7	18.6	.725	24.1	.75	26.3	.775	28.3
FS48340219204	2	.8	30.6	.9	40.9	.925	43.5	.95	45.4	1.	48.6
FS48340219205	2	1.1	55.5	1.125	55.4	1.15	54.2	1.175	52.3	1.2	51.3
FS48340219206	2	1.275	56.5	1.3	56.4	1.325	56.3	1.375	51.1	1.4	46.8
FS48340219207	2	1.425	42.5	1.45	41.1	1.5	42.8	1.6	47.3	1.8	45.0
FS48340219208	2	2.	37.7	2.5	21.5	3.	1.7	4.	13.6	5.	16.2
FS48340219209	2	6.	2.6	7.	1.9	8.	1.3	9.	1.5	10.	2.6
FS48340219210	2	12.	3.5	14.	2.4	16.	2.0	18.	2.3	20.	2.3
FS48340219211	2	22.	2.3	24.	2.5	25.	1.9				
FS48340219001	3	001	1	.3	25.	53				40.	0.
FS48340219201	3	.3	2.3	.325	4.3	.375	4.6	.4	5.6	.45	9.9
FS48340219202	3	.475	11.5	.5	12.7	.525	13.9	.55	15.4	.6	15.8
FS48340219203	3	.65	16.2	.675	16.0	.7	19.0	.725	24.8	.75	27.3
FS48340219204	3	.775	29.4	.8	32.0	.9	42.1	.95	46.1	1.	49.4
FS48340219205	3	1.1	56.1	1.125	56.0	1.175	52.8	1.2	52.0	1.225	53.2
FS48340219206	3	1.25	55.6	1.275	57.2	1.3	57.0	1.325	56.7	1.375	50.9
FS48340219207	3	1.4	46.6	1.425	42.2	1.5	44.3	1.6	48.1	1.8	46.1
FS48340219208	3	2.	38.6	2.5	22.5	3.	2.0	4.	14.7	5.	17.6
FS48340219209	3	6.	2.9	7.	2.2	8.	1.6	9.	1.9	10.	3.2
FS48340219210	3	12.	4.1	14.	2.9	16.	2.7	18.	2.8	20.	2.8
FS48340219211	3	22.	3.1	24.	3.3	25.	2.6				
FS48340219001	4	001	1	.3	25.	54				50.	0.
FS48340219201	4	.3	2.6	.325	4.4	.35	4.8	.375	4.9	.4	6.1
FS48340219202	4	.45	11.3	.5	13.8	.525	15.1	.55	16.7	.6	17.1

APPENDIX B

TABLE B-3. (CONTINUED)

FS48340219203	4	.625	17.4	.65	17.4	.675	17.1	.7	20.2	.725	26.4
FS48340219204	4	.75	28.8	.775	30.8	.8	33.5	.9	43.5	.95	47.4
FS48340219205	4	1.	50.6	1.1	57.1	1.125	57.0	1.15	56.1	1.175	54.5
FS48340219206	4	1.2	53.8	1.225	53.9	1.275	58.6	1.3	58.5	1.325	58.4
FS48340219207	4	1.375	53.5	1.4	50.4	1.45	43.7	1.5	45.8	1.6	50.0
FS48340219208	4	1.8	47.1	2.	40.5	2.5	23.8	3.	2.3	4.	16.3
FS48340219209	4	5.	19.5	6.	3.7	7.	2.8	8.	2.1	9.	2.2
FS48340219210	4	10.	3.6	12.	4.9	14.	3.4	16.	3.1	18.	3.5
FS48340219211	4	20.	3.6	22.	3.4	24.	3.6	25.	4.0		
FS48340219001	5	001	1	.3	25.	49				60.	0.
FS48340219201	5	.3	3.7	.325	5.2	.35	5.4	.375	5.8	.4	7.5
FS48340219202	5	.45	12.9	.5	15.3	.55	18.3	.575	19.0	.6	19.0
FS48340219203	5	.65	19.0	.675	18.8	.7	23.1	.725	28.2	.775	32.7
FS48340219204	5	.8	34.7	.825	36.8	.9	43.4	.95	47.7	1.	51.2
FS48340219205	5	1.1	58.2	1.125	58.2	1.15	57.6	1.2	55.0	1.3	60.5
FS48340219206	5	1.375	55.8	1.4	52.7	1.45	40.5	1.5	47.9	1.6	52.2
FS48340219207	5	1.8	48.5	2.	41.8	2.5	25.3	3.	2.7	4.	18.5
FS48340219208	5	5.	22.1	6.	4.7	7.	3.6	8.	2.9	9.	3.1
FS48340219209	5	10.	4.9	12.	5.7	14.	4.2	16.	4.4	18.	4.5
FS48340219210	5	20.	4.7	22.	5.1	24.	4.8	25.	4.9		
FS48340219001	6	001	1	.3	25.	53				70.	0.
FS48340219201	6	.3	4.3	.325	6.0	.35	6.7	.375	6.7	.4	8.3
FS48340219202	6	.45	14.0	.5	17.2	.525	18.8	.55	21.2	.6	21.5
FS48340219203	6	.65	21.9	.675	21.4	.7	24.2	.725	30.3	.775	34.8
FS48340219204	6	.8	36.8	.9	45.6	.95	49.5	1.	53.0	1.1	59.2
FS48340219205	6	1.125	59.0	1.175	57.2	1.2	57.1	1.225	58.1	1.25	59.6
FS48340219206	6	1.3	61.5	1.325	61.0	1.35	59.3	1.375	57.4	1.4	54.5
FS48340219207	6	1.45	48.9	1.5	51.1	1.55	53.2	1.6	55.3	1.8	50.4
FS48340219208	6	2.	44.0	2.5	27.4	3.	3.5	4.	20.6	5.	25.1
FS48340219209	6	6.	6.0	7.	5.0	8.	4.2	9.	4.4	10.	6.3
FS48340219210	6	12.	7.7	14.	5.8	16.	5.2	18.	6.2	20.	6.5
FS48340219211	6	22.	8.2	24.	5.9	25.	5.7				
FS48340219001	7	001	1	.3	25.	50				75.	0.
FS48340219201	7	.3	4.8	.325	7.0	.35	7.5	.375	7.6	.4	9.2
FS48340219202	7	.45	15.4	.5	19.2	.55	21.7	.6	22.3	.65	22.8
FS48340219203	7	.675	22.8	.7	25.9	.725	31.3	.75	33.6	.775	35.6
FS48340219204	7	.8	37.5	.9	46.9	.95	50.6	1.	53.9	1.1	60.5
FS48340219205	7	1.125	60.5	1.175	58.7	1.2	58.5	1.275	63.2	1.3	63.4
FS48340219206	7	1.325	62.9	1.375	60.1	1.4	56.9	1.45	50.6	1.5	51.8
FS48340219207	7	1.6	54.4	1.8	51.5	2.	45.5	2.5	28.9	3.	4.1
FS48340219208	7	4.	22.3	5.	26.9	6.	7.4	7.	6.3	8.	5.5
FS48340219209	7	9.	5.8	10.	7.8	12.	8.9	14.	7.5	16.	7.5
FS48340219210	7	18.	7.8	20.	8.3	22.	8.8	24.	8.6	25.	8.4
FS48340219001	8	001	1	.3	25.	51				80.	0.
FS48340219201	8	.3	6.4	.325	7.8	.35	7.9	.375	8.3	.4	10.1
FS48340219202	8	.45	15.2	.5	18.1	.55	21.0	.6	23.0	.65	23.2
FS48340219203	8	.675	23.0	.7	26.4	.725	31.7	.775	35.6	.8	38.0
FS48340219204	8	.9	47.2	.95	51.8	1.	56.0	1.1	63.3	1.125	64.[illegible]

APPENDIX B

TABLE B-3. (CONTINUED)

FS48340219205	8	1.2	62.1	1.225	62.7	1.25	65.0	1.275	66.6	1.3	67.0
FS48340219206	8	1.325	67.5	1.375	62.9	1.4	60.1	1.45	51.6	1.5	54.5
FS48340219207	8	1.55	56.9	1.6	58.5	1.8	52.9	2.	47.7	2.5	30.7
FS48340219208	8	3.	5.3	4.	24.1	5.	28.7	6.	8.9	7.	7.9
FS48340219209	8	8.	7.3	9.	7.4	10.	9.7	12.	11.8	14.	9.7
FS48340219210	8	16.	9.6	18.	10.7	20.	10.8	22.	10.0	24.	11.9
FS48340219211	8	25.	10.6								

APPENDIX B

TABLE B-4. SPECTRAL SCIENCES: BARK SAMPLE #2, 2:16PM, NORTH-EAST SIDE, 51" UP. PHI = 0 DIRECTIONAL AND HEMISPHERICAL EMITTANCE AS A FUNCTION OF INCIDENT ANGLE AND TEMPERATURE DATA CORRECTED FOR INSTRUMENTATION POLARIZATION

FS4834021: SPECTRAL SCIENCES: BARK SAMPLE #2, 2:16PM, NORTH-EAST SIDE, 51" UP. PHI=0

Emittance tabulated as a function of zenith angle and temperature:

Zenith angle (degrees)	Wavelength range (microns)	Temperature (degrees Kelvin) 100	200	300	400	500	600
20	0.300 - 25.000	0.975	0.976	0.972	0.963	0.951	0.939
30	0.300 - 25.000	0.977	0.976	0.973	0.964	0.951	0.938
40	0.300 - 25.000	0.970	0.970	0.967	0.958	0.945	0.932
50	0.300 - 25.000	0.965	0.964	0.962	0.951	0.937	0.923
60	0.300 - 25.000	0.952	0.953	0.951	0.940	0.925	0.909
70	0.300 - 25.000	0.935	0.937	0.935	0.924	0.908	0.892
75	0.300 - 25.000	0.917	0.920	0.919	0.909	0.893	0.877
80	0.300 - 25.000	0.894	0.897	0.898	0.888	0.874	0.859
Hemispherical emittance:		0.947	0.947	0.945	0.935	0.922	0.908

TABLE B-5. SPECTRAL SCIENCES: BARK SAMPLE #2, 2:16PM, NORTH-EAST SIDE, 51" UP. PHI = 0 SOLAR ABSORBPTANCE AS A FUNCTION OF INCIDENT ANGLE DATA CORRECTED FOR INSTRUMENTATION POLARIZATION

FS4834021 Surface Optics Corp.
SPECTRAL SCIENCES: BARK SAMPLE #2, 2:16PM,
NORTH-EAST SIDE, 51" UP. PHI=0

20 degrees: The exoatmospheric solar absorptance is 0.743.
30 degrees: The exoatmospheric solar absorptance is 0.738.
40 degrees: The exoatmospheric solar absorptance is 0.732.
50 degrees: The exoatmospheric solar absorptance is 0.719.
60 degrees: The exoatmospheric solar absorptance is 0.705.
70 degrees: The exoatmospheric solar absorptance is 0.687.
75 degrees: The exoatmospheric solar absorptance is 0.675.
80 degrees: The exoatmospheric solar absorptance is 0.665.

APPENDIX B

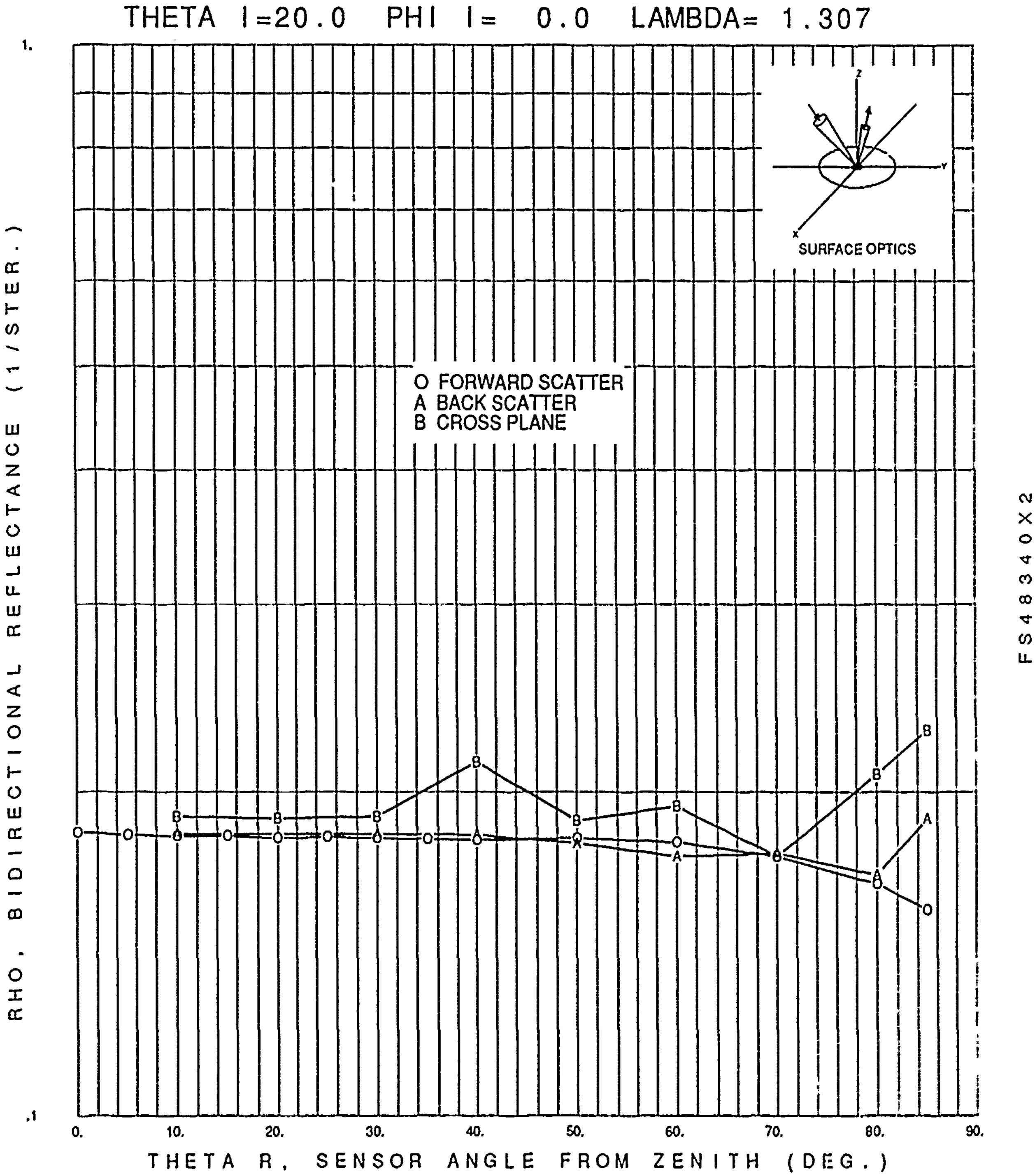


FIGURE B-10. SPECTRAL SCIENCES: BARK SAMPLE #2, 2:16PM, NORTH-EAST SIDE, 51" UP
BIDIRECTIONAL REFLECTANCE VS. REFLECTED POLAR ANGLE
WAVELENGTH 1.307 MICROMETERS
INCIDENT POLAR ANGLE 20.0 DEGREES

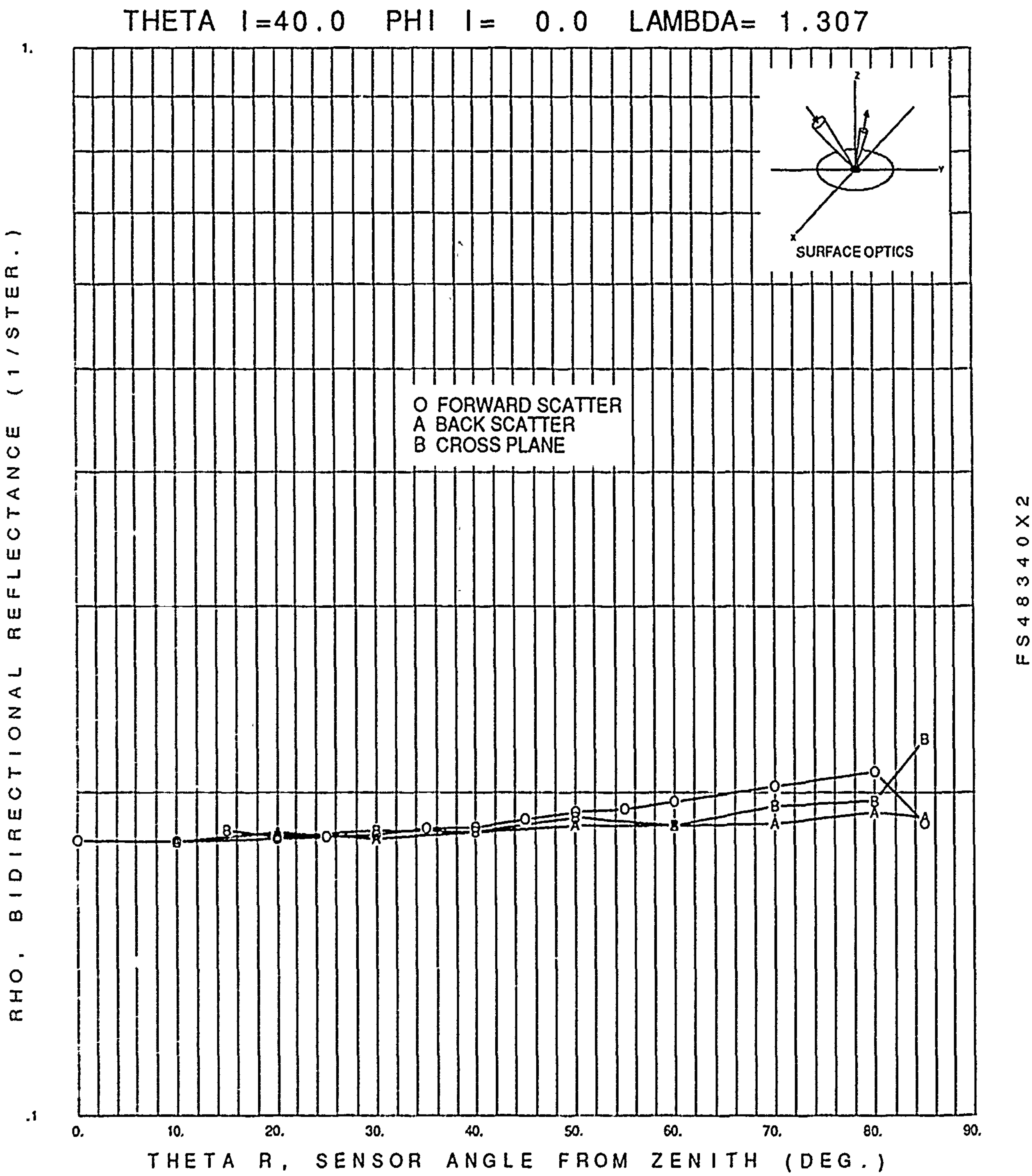


FIGURE B-11. SPECTRAL SCIENCES: BARK SAMPLE #2,
2:16PM, NORTH-EAST SIDE, 51" UP
BIDIRECTIONAL REFLECTANCE VS. REFLECTED POLAR ANGLE
WAVELENGTH 1.307 MICROMETERS
INCIDENT POLAR ANGLE 40.0 DEGREES

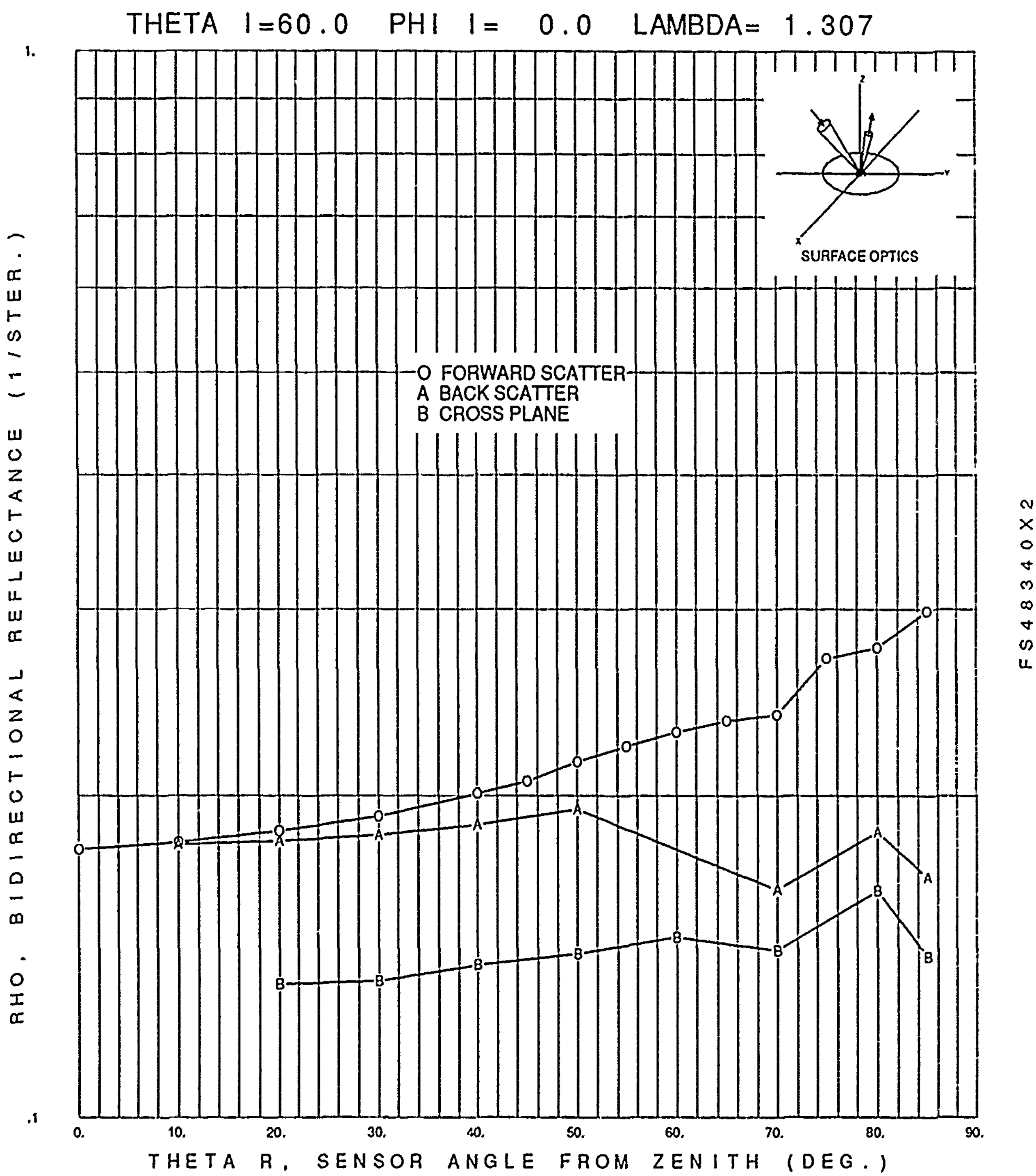


FIGURE B-12. SPECTRAL SCIENCES: BARK SAMPLE #2, 2:16PM, NORTH-EAST SIDE, 51" UP
BIDIRECTIONAL REFLECTANCE VS. REFLECTED POLAR ANGLE
WAVELENGTH 1.307 MICROMETERS
INCIDENT POLAR ANGLE 60.0 DEGREES

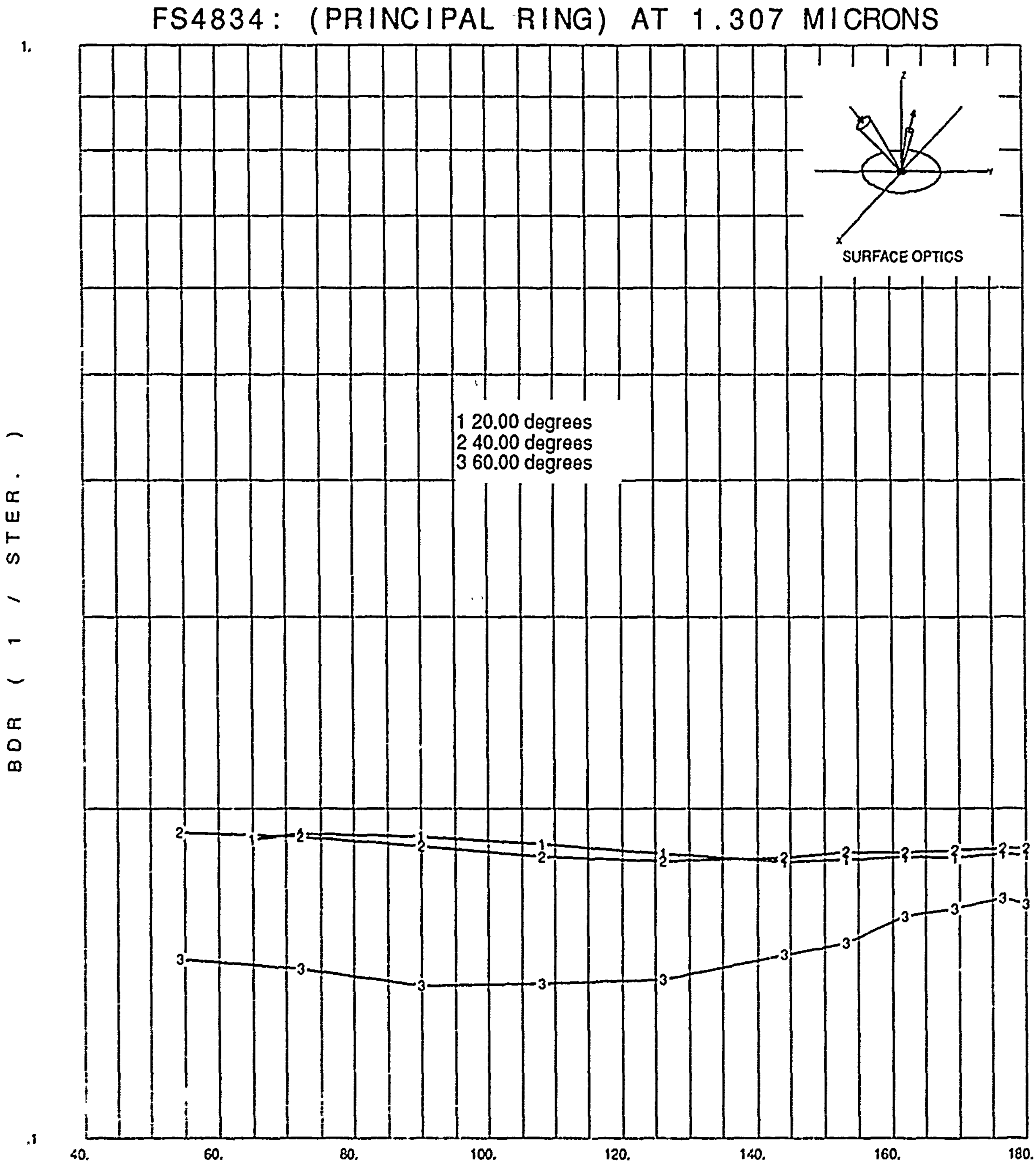


FIGURE B-13. SPECTRAL SCIENCES: BARK SAMPLE #2,
2:16PM, NORTH-EAST SIDE, 51" UP, PHI = 0
BIDIRECTIONAL REFLECTANCE VS. REFLECTED AZIMUTH ANGLE
PRINCIPAL RING AT 1.307 MICROMETERS
INCIDENT POLAR ANGLES 20, 40 AND 60 DEGREES

APPENDIX B

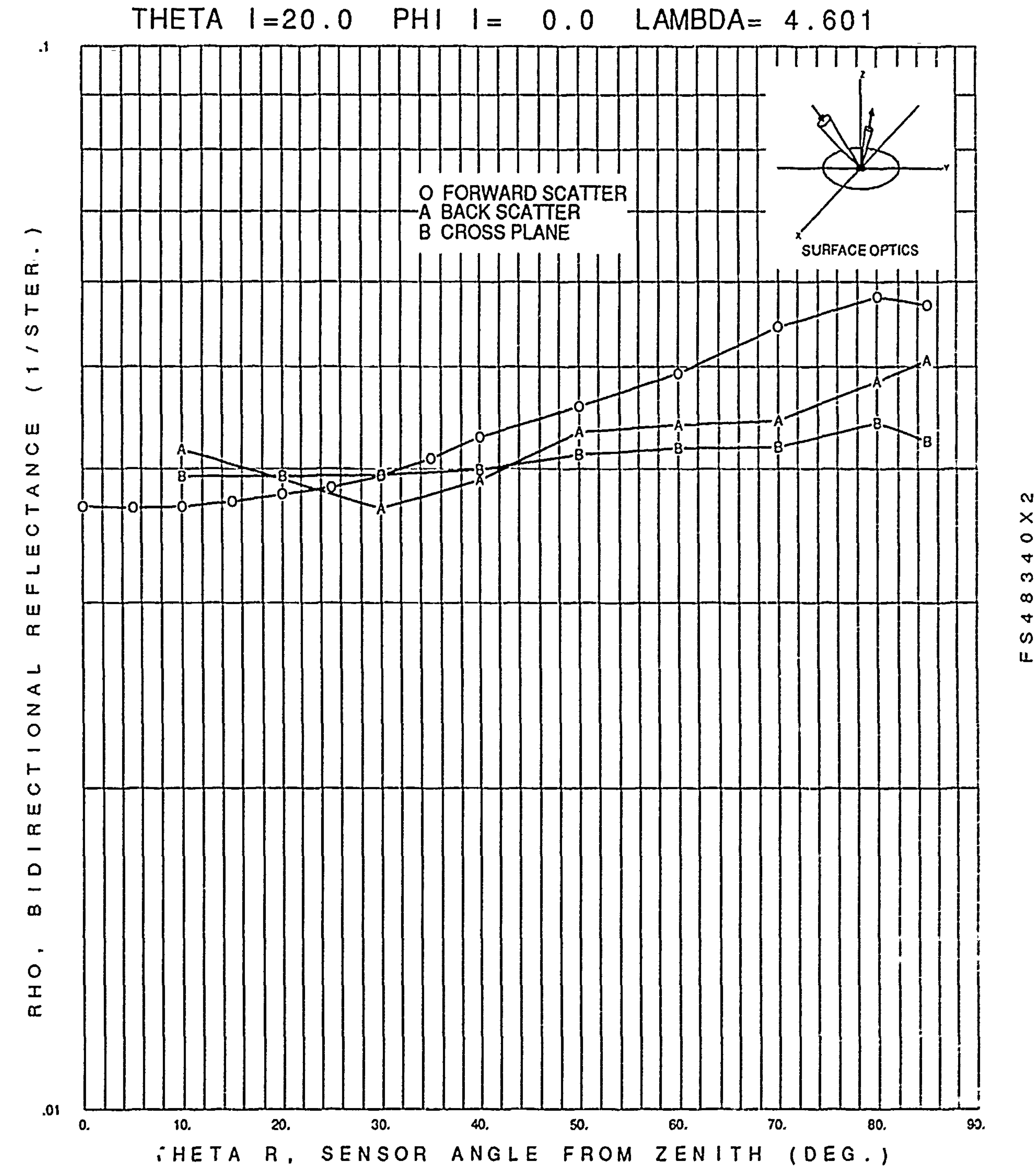


FIGURE B-14. SPECTRAL SCIENCES: BARK SAMPLE #2,
2:16PM, NORTH-EAST SIDE, 51" UP
BIDIRECTIONAL REFLECTANCE VS. REFLECTED POLAR ANGLE
WAVELENGTH 4.601 MICROMETERS
INCIDENT POLAR ANGLE 20.0 DEGREES

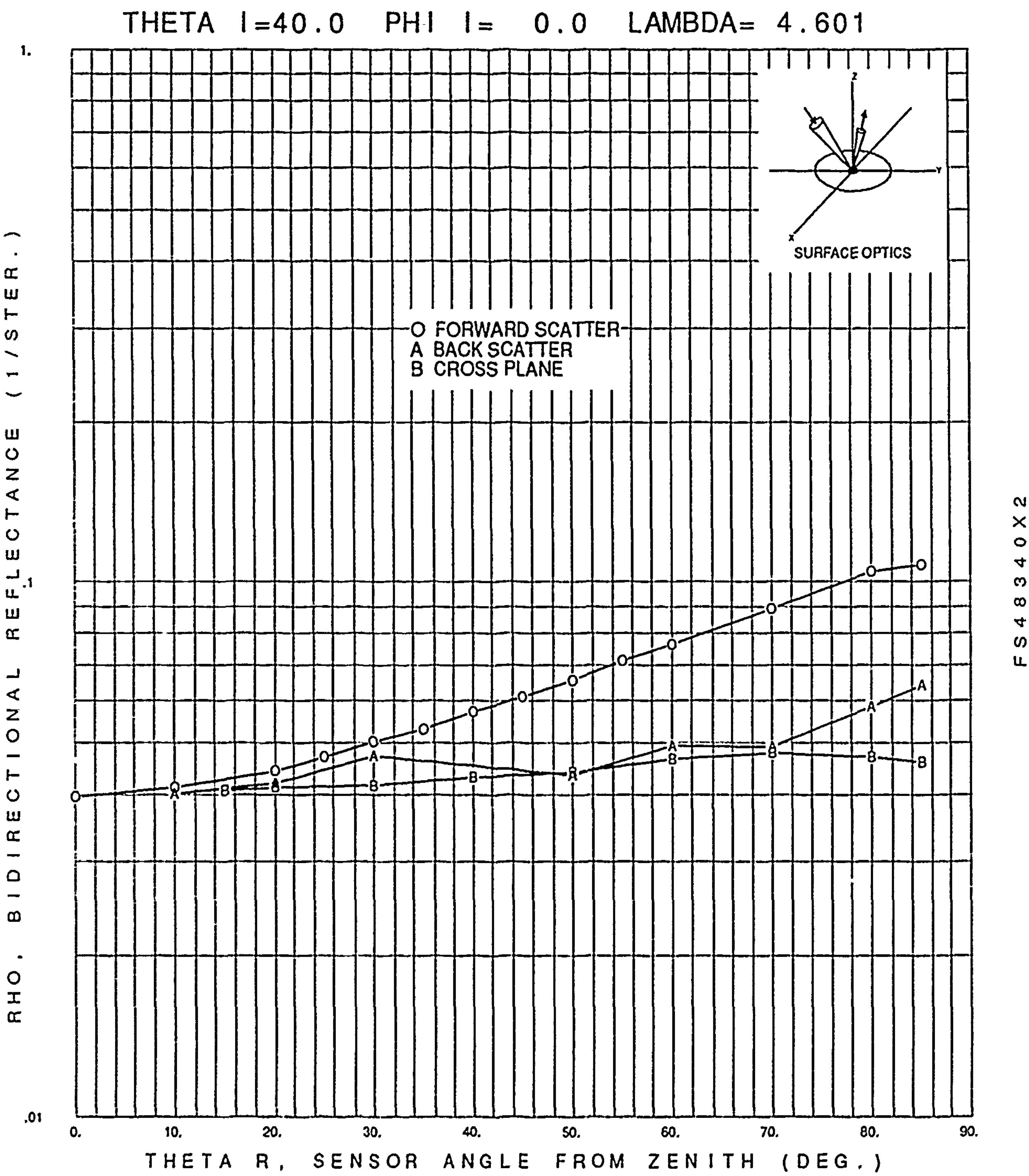


FIGURE B-15. SPECTRAL SCIENCES: BARK SAMPLE #2,
2:16PM, NORTH-EAST SIDE, 51" UP
BIDIRECTIONAL REFLECTANCE VS. REFLECTED POLAR ANGLE
WAVELENGTH 4.601 MICROMETERS
INCIDENT POLAR ANGLE 40.0 DEGREES

APPENDIX B

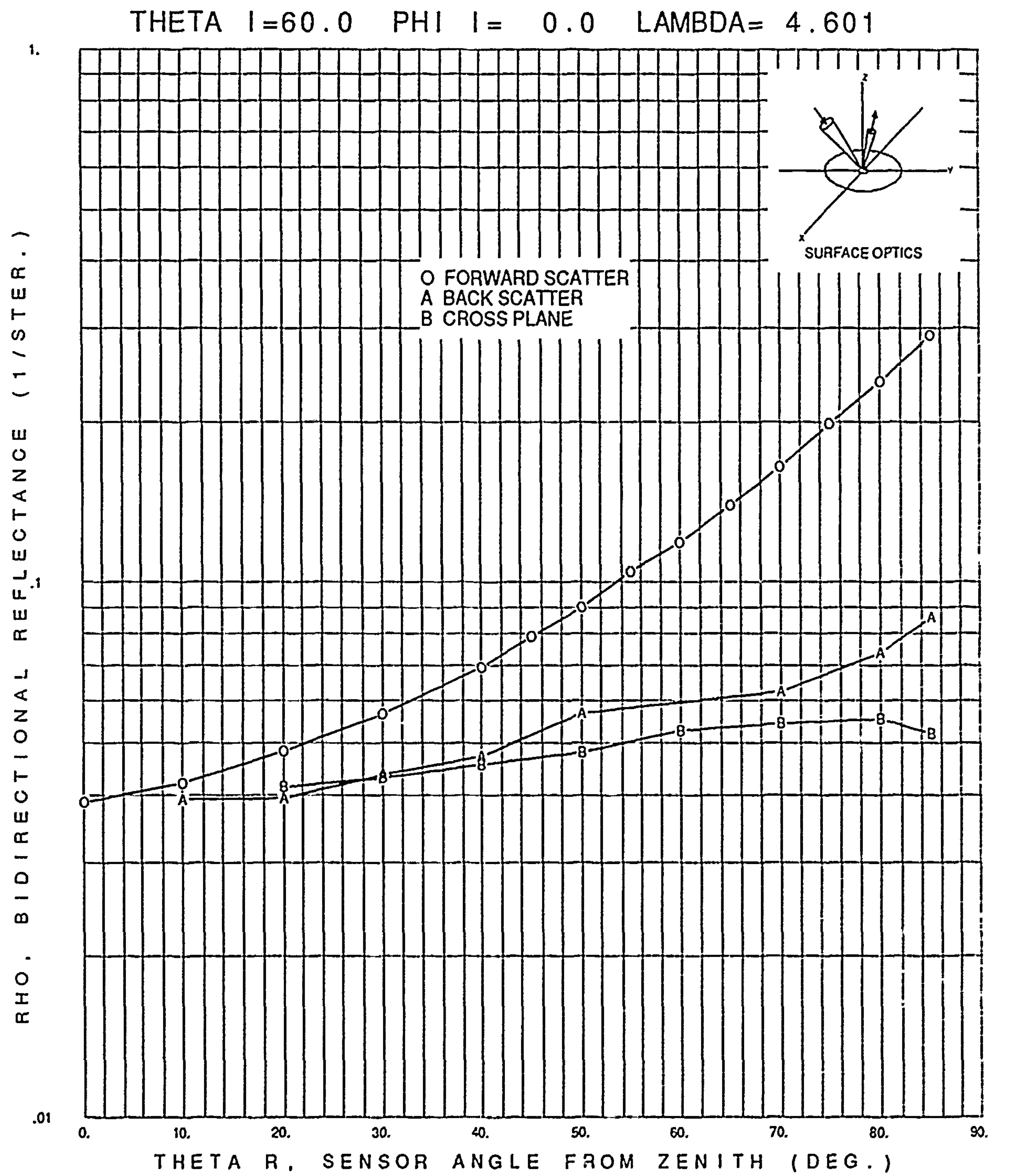


FIGURE B-16. SPECTRAL SCIENCES: BARK SAMPLE #2, 2:16PM, NORTH-EAST SIDE, 51" UP
BIDIRECTIONAL REFLECTANCE VS. REFLECTED POLAR ANGLE
WAVELENGTH 4.601 MICROMETERS
INCIDENT POLAR ANGLE 60.0 DEGREES

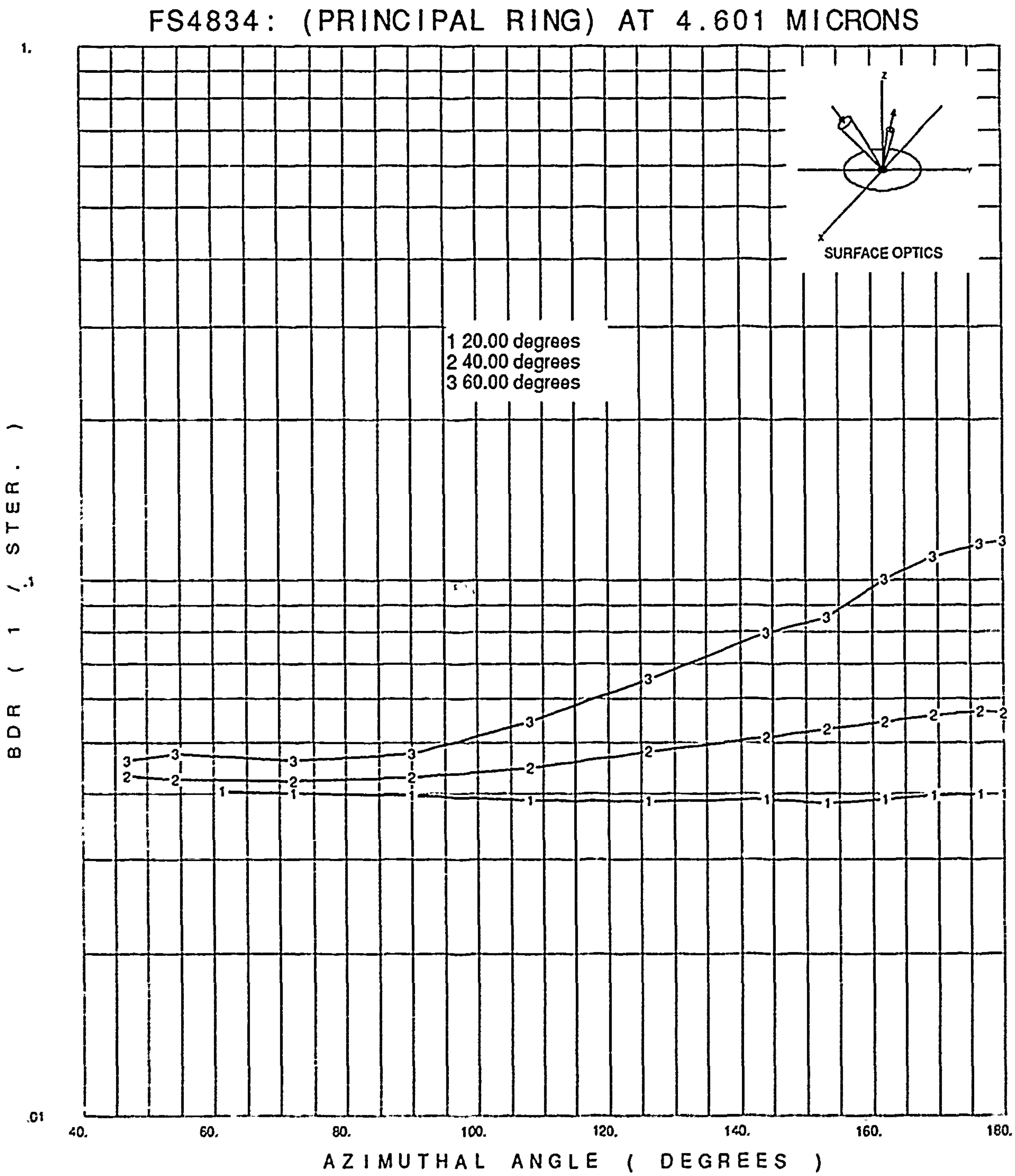


FIGURE B-17. SPECTRAL SCIENCES: BARK SAMPLE #2, 2:16PM, NORTH-EAST SIDE, 51" UP, PHI = 0 BIDIRECTIONAL REFLECTANCE VS. REFLECTED AZIMUTH ANGLE PRINCIPAL RING AT 4.601 MICROMETERS INCIDENT POLAR ANGLES 20, 40 AND 60 DEGREES

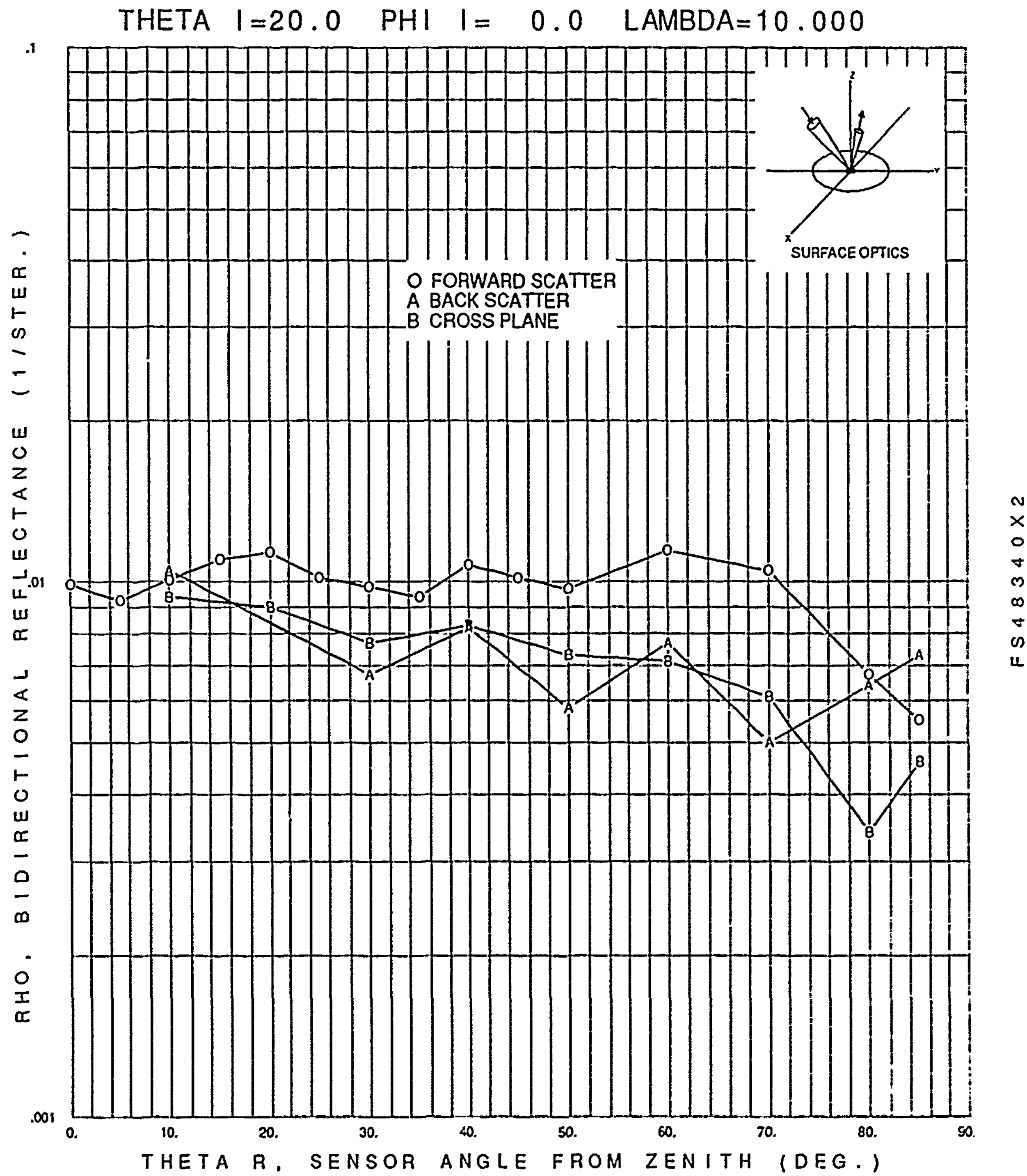


FIGURE B-18. SPECTRAL SCIENCES: BARK SAMPLE #2, 2:16PM, NORTH-EAST SIDE, 51" UP
BIDIRECTIONAL REFLECTANCE VS. REFLECTED POLAR ANGLE
WAVELENGTH 10.000 MICROMETERS
INCIDENT POLAR ANGLE 20.0 DEGREES

APPENDIX B

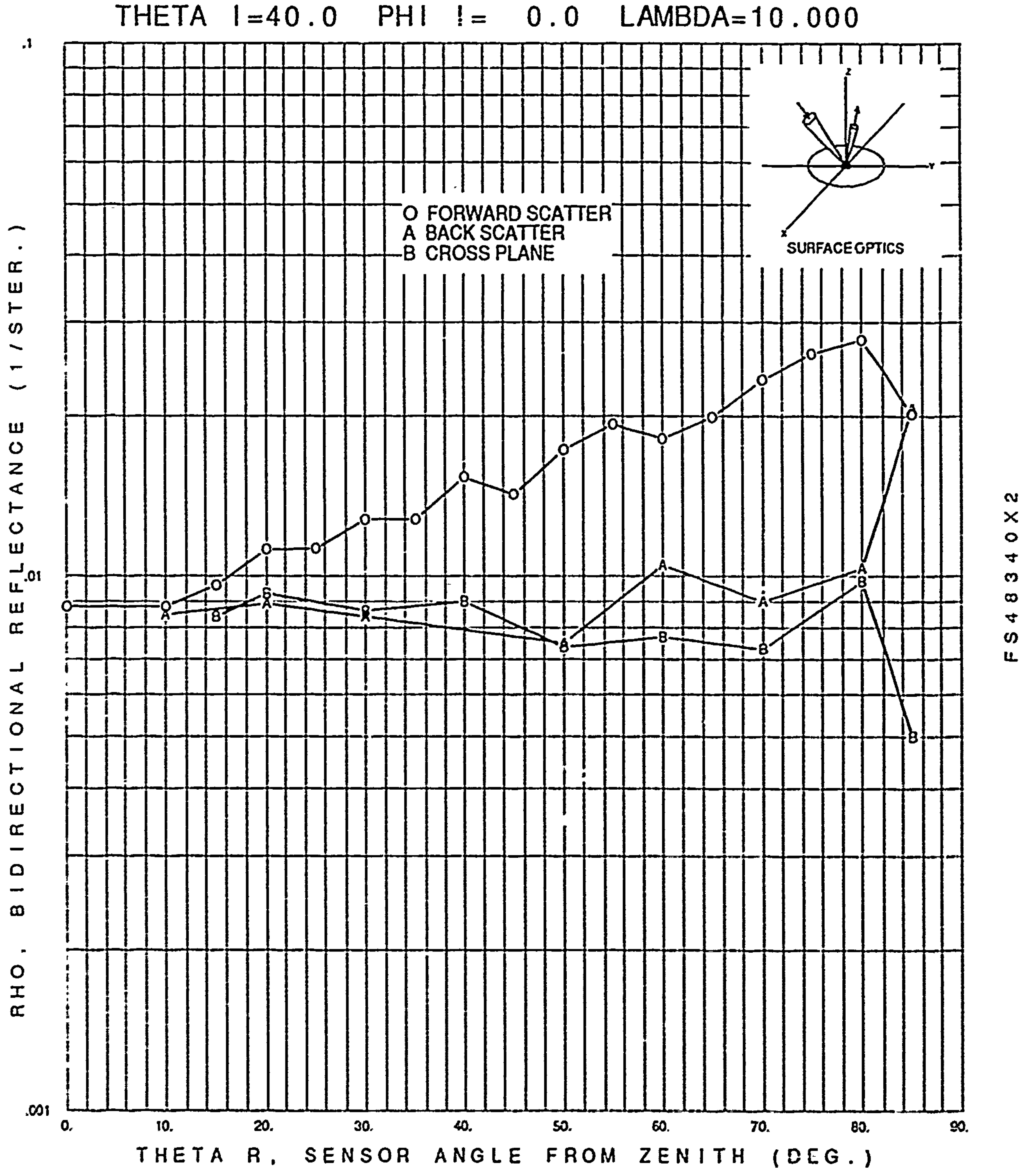
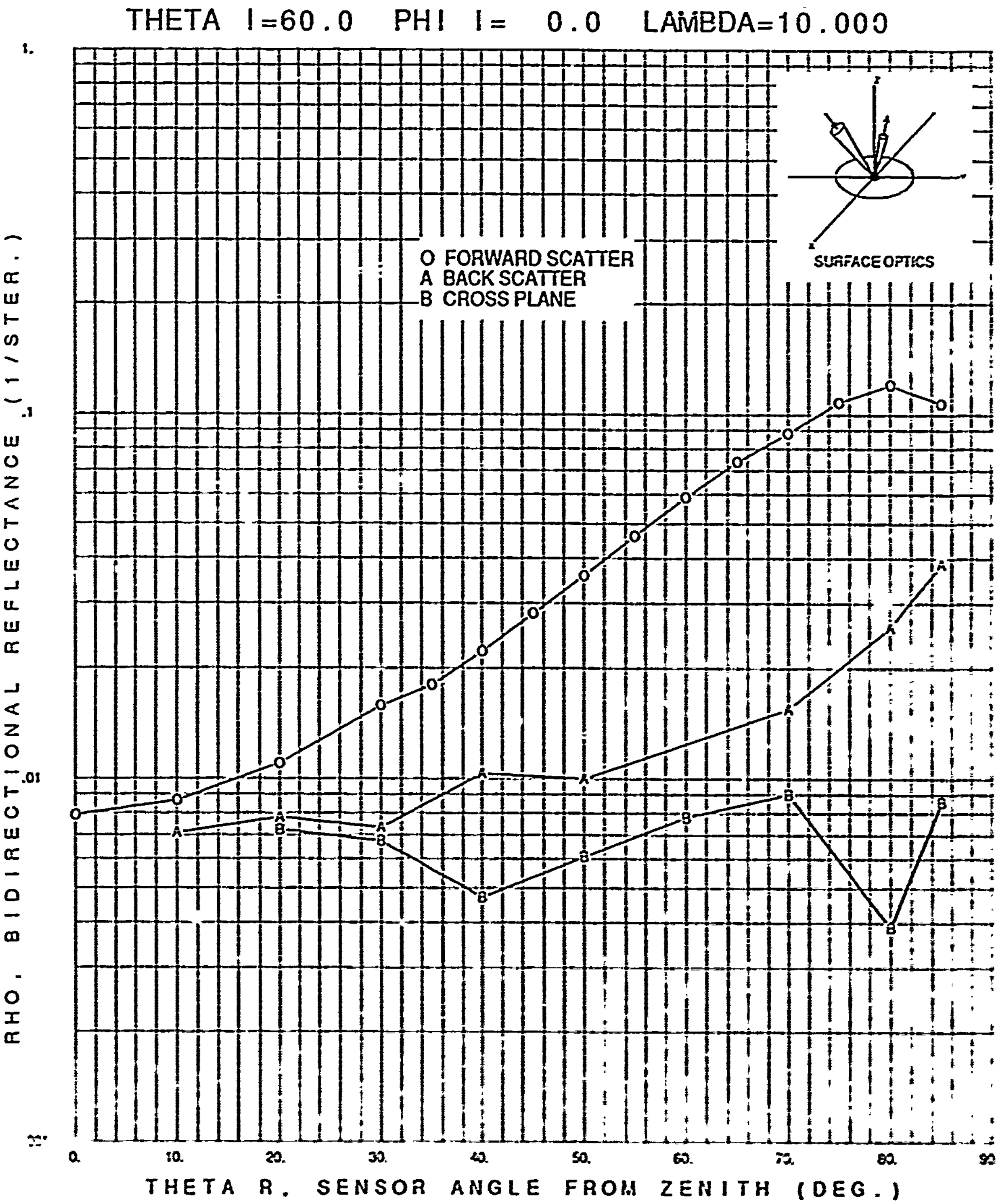


FIGURE B-19. SPECTRAL SCIENCES: BARK SAMPLE #2, 2:16PM, NORTH-EAST SIDE, 51" UP
BIDIRECTIONAL REFLECTANCE VS. REFLECTED POLAR ANGLE
WAVELENGTH 10.000 MICROMETERS
INCIDENT POLAR ANGLE 40.0 DEGREES



FS48340X2

FIGURE B-20. SPECTRAL SCIENCES: BARK SAMPLE #2,
2:16PM, NORTH-EAST SIDE, 51" UP
BIDIRECTIONAL REFLECTANCE VS. REFLECTED POLAR ANGLE
WAVELENGTH 10.000 MICROMETERS
INCIDENT POLAR ANGLE 60.0 DEGREES

APPENDIX B

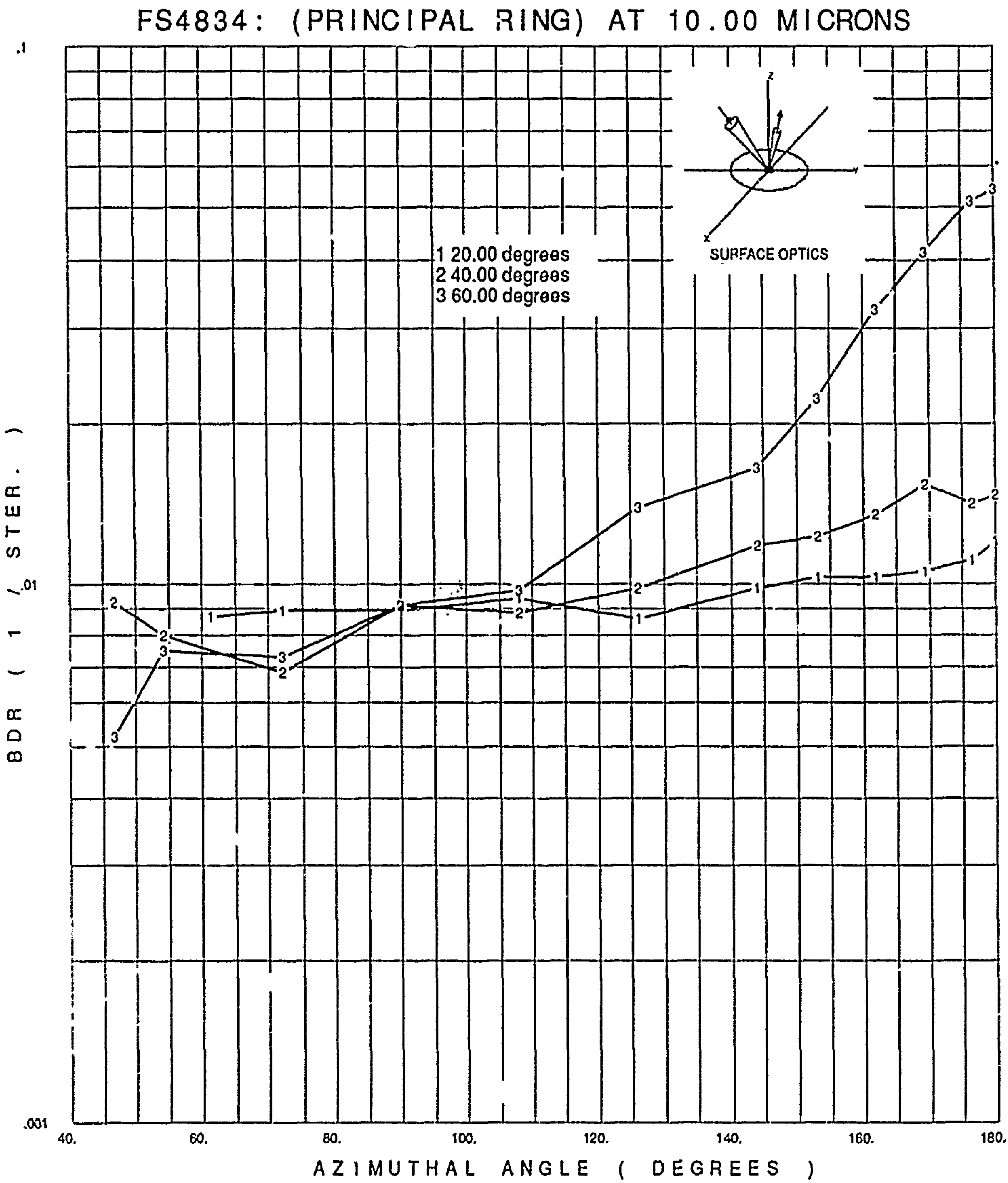


FIGURE B-21. SPECTRAL SCIENCES: BARK SAMPLE #2,
2:16PM, NORTH-EAST SIDE, 51" UP, PHI = 0
BIDIRECTIONAL REFLECTANCE VS. REFLECTED AZIMUTH ANGLE
PRINCIPAL RING AT 10.00 MICROMETERS
INCIDENT POLAR ANGLES 20, 40 AND 60 DEGREES

APPENDIX B

TABLE B-6. SPECTRAL SCIENCES: BARK SAMPLE #2, 2:16PM, NORTH-EAST SIDE, 51" UP. PHI - 0
BIDIRECTIONAL REFLECTANCE VS. REFLECTED POLAR ANGLE
ERAS DATA
WAVELENGTH 1.307, 4.601, 10 MICROMETERS
INCIDENT POLAR ANGLES 20, 40, 60 DEGREES

FS48340X25001		36	013								
FS48340X25101		SPECTRAL SCIENCES: BARK SAMPLE #2, 2:16 PM, NORTH-EAST SIDE,									
FS48340X25102		51 " UP.									
FS48340X27004						760.					
FS48340X29001	1		4 10	0.0	85.0	14	1.307	20.0	0.0		180.0
FS48340X29201	1	0.0	.1837	5.0	.1825	10.0	.1822	15.0	.1823	20.0	.1815
FS48340X29202	1	25.0	.1817	30.0	.1812	35.0	.181	40.0	.1806	50.0	.1813
FS48340X29203	1	60.0	.1798	70.0	.1747	80.0	.1645	85.0	.155		
FS48340X29001	2		4 10	10.0	85.0	8	1.307	20.0	0.0		0.0
FS48340X29201	2	10.0	.1832	30.0	.1832	40.0	.1827	50.0	.1792	60.0	.1746
FS48340X29202	2	70.0	.1752	80.0	.1675	85.0	.1888				
FS48340X29001	3		4 10	10.0	85.0	9	1.307	20.0	0.0		90.0
FS48340X29201	3	10.0	.1897	20.0	.1889	30.0	.19	40.0	.2132	50.0	.188
FS48340X29202	3	60.0	.194	70.0	.1747	80.0	.2074	85.0	.2285		
FS48340X29001	4		5 10	64.8	180.0	11	1.307	20.0	0.0	20.0	
FS48340X29201	4	64.8	.1871	72.0	.1894	90.0	.1887	108.0	.1854	126.0	.1817
FS48340X29202	4	144.0	.1789	153.0	.1795	162.0	.1806	169.2	.1799	176.4	.1817
FS48340X29203	4	180.0	.1808								
FS48340X29001	5		4 10	0.0	85.0	14	1.307	40.0	0.0		180.0
FS48340X29201	5	0.0	.1806	10.0	.1801	20.0	.1815	25.0	.1824	30.0	.1832
FS48340X29202	5	35.0	.1854	40.0	.1858	45.0	.189	50.0	.192	55.0	.193
FS48340X29203	5	60.0	.1963	70.0	.2025	80.0	.2092	85.0	.1877		
FS48340X29001	6		4 10	10.0	85.0	8	1.307	40.0	0.0		0.0
FS48340X29201	6	10.0	.1799	20.0	.1836	30.0	.1815	50.0	.1867	60.0	.1865
FS48340X29202	6	70.0	.1876	80.0	.1921	85.0	.1901				
FS48340X29001	7		4 10	15.0	85.0	9	1.307	40.0	0.0		90.0
FS48340X29201	7	15.0	.1845	20.0	.1822	30.0	.1845	40.0	.1841	50.0	.19
FS48340X29202	7	60.0	.1869	70.0	.1944	80.0	.197	85.0	.2242		
FS48340X29001	8		5 10	54.0	180.0	11	1.307	40.0	0.0	40.0	
FS48340X29201	8	54.0	.1902	72.0	.1886	90.0	.1844	108.0	.1805	126.0	.1791
FS48340X29202	8	144.0	.18	153.0	.1822	162.0	.1825	169.2	.183	176.4	.1839
FS48340X29203	8	180.0	.1841								
FS48340X29001	9		4 10	0.0	85.0	14	1.307	60.0	0.0		180.0
FS48340X29201	9	0.0	.179	10.0	.1814	20.0	.1856	30.0	.1917	40.0	.2014
FS48340X29202	9	45.0	.2067	50.0	.2152	55.0	.2224	60.0	.2291	65.0	.2349
FS48340X29203	9	70.0	.2379	75.0	.2691	80.0	.2755	85.0	.2987		
FS48340X29001	10		4 10	10.0	85.0	8	1.307	60.0	0.0		0.0
FS48340X29201	10	10.0	.1804	20.0	.1818	30.0	.1841	40.0	.1882	50.0	.1944
FS48340X29202	10	70.0	.1637	80.0	.1855	85.0	.168				
FS48340X29001	11		4 10	20.0	85.0	8	1.307	60.0	0.0		90.0
FS48340X29201	11	20.0	.1337	30.0	.1345	40.0	.1394	50.0	.1428	60.0	.1478
FS48340X29202	11	70.0	.1437	80.0	.1631	85.0	.1419				
FS48340X29001	12		5 10	54.0	180.0	11	1.307	60.0	0.0	60.0	
FS48340X29201	12	54.0	.1458	72.0	.1432	90.0	.138	108.0	.1386	126.0	.1399
FS48340X29202	12	144.0	.1471	153.0	.151	162.0	.1595	169.2	.1621	176.4	.166
FS48340X29203	12	180.0	.1634								
FS48340X29001	13		4 10	0.0	85.0	14	4.601	20.0	0.0		180.0
FS48340X29201	13	0.0	.0369	5.0	.0368	10.0	.0369	15.0	.0373	20.0	.0379

APPENDIX B

TABLE B-6. (CONTINUED)

FS48340X29202	13	25.0	.0384	30.0	.0394	35.0	.0409	40.0	.0428	50.0	.0457
FS48340X29203	13	60.0	.0491	70.0	.0544	80.0	.0581	85.0	.057		
FS48340X29001	14		4 10	10.0	85.0	8	4.601	20.0	0.0		0.0
FS48340X29201	14	10.0	.0417	30.0	.0367	40.0	.0391	50.0	.0433	60.0	.044
FS48340X29202	14	70.0	.0444	80.0	.0483	85.0	.0505				
FS48340X29001	15		4 10	10.0	85.0	9	4.601	20.0	0.0		90.0
FS48340X29201	15	10.0	.0394	20.0	.0394	30.0	.0395	40.0	.0399	50.0	.0413
FS48340X29202	15	60.0	.0418	70.0	.0419	80.0	.0442	85.0	.0424		
FS48340X29001	16		5 10	61.2	180.0	11	4.601	20.0	0.0	20.0	
FS48340X29201	16	61.2	.0404	72.0	.0399	90.0	.0396	108.0	.0388	126.0	.0387
FS48340X29202	16	144.0	.039	153.0	.0382	162.0	.0391	169.2	.0396	176.4	.0398
FS48340X29203	16	180.0	.0398								
FS48340X29001	17		4 10	0.0	85.0	14	4.601	40.0	0.0		180.0
FS48340X29201	17	0.0	.0397	10.0	.0412	20.0	.0443	25.0	.0473	30.0	.0503
FS48340X29202	17	35.0	.053	40.0	.0571	45.0	.0609	50.0	.0656	55.0	.0711
FS48340X29203	17	60.0	.0763	70.0	.0891	80.0	.1043	85.0	.1079		
FS48340X29001	18		4 10	10.0	85.0	8	4.601	40.0	0.0		0.0
FS48340X29201	18	10.0	.0403	20.0	.0421	30.0	.0475	50.0	.0436	60.0	.0495
FS48340X29202	18	70.0	.0494	80.0	.0582	85.0	.064				
FS48340X29001	19		4 10	15.0	85.0	9	4.601	40.0	0.0		90.0
FS48340X29201	19	15.0	.0408	20.0	.0413	30.0	.0416	40.0	.043	50.0	.0442
FS48340X29202	19	60.0	.0467	70.0	.0479	80.0	.0472	85.0	.046		
FS48340X29001	20		5 10	46.8	180.0	12	4.601	40.0	0.0	40.0	
FS48340X29201	20	46.8	.0432	54.0	.0425	72.0	.0421	90.0	.043	108.0	.0446
FS48340X29202	20	126.0	.048	144.0	.0509	153.0	.053	162.0	.0546	169.2	.0559
FS48340X29203	20	176.4	.0569	180.0	.0564						
FS48340X29001	21		4 10	0.0	85.0	14	4.601	60.0	0.0		180.0
FS48340X29201	21	0.0	.039	10.0	.0423	20.0	.0483	30.0	.0567	40.0	.0693
FS48340X29202	21	45.0	.0789	50.0	.0901	55.0	.1042	60.0	.119	65.0	.1402
FS48340X29203	21	70.0	.1646	75.0	.198	80.0	.2382	85.0	.2909		
FS48340X29001	22		4 10	10.0	85.0	8	4.601	60.0	0.0		0.0
FS48340X29201	22	10.0	.0393	20.0	.0395	30.0	.0438	40.0	.0474	50.0	.0569
FS48340X29202	22	70.0	.0624	80.0	.0738	85.0	.0857				
FS48340X29001	23		4 10	20.0	85.0	8	4.601	60.0	0.0		90.0
FS48340X29201	23	20.0	.0415	30.0	.0431	40.0	.0456	50.0	.0482	60.0	.0528
FS48340X29202	23	70.0	.0546	80.0	.0553	85.0	.0521				
FS48340X29001	24		5 10	46.8	180.0	12	4.601	60.0	0.0	60.0	
FS48340X29201	24	46.8	.0459	54.0	.0475	72.0	.0459	90.0	.0475	108.0	.0545
FS48340X29202	24	126.0	.0651	144.0	.0795	153.0	.0854	162.0	.1004	169.2	.1105
FS48340X29203	24	176.4	.1169	180.0	.118						
FS48340X29001	25		4 10	0.0	85.0	15	10.000	20.0	0.0		180.0
FS48340X29201	25	0.0	.0099	5.0	.0092	10.0	.0101	15.0	.011	20.0	.0114
FS48340X29202	25	25.0	.0102	30.0	.0098	35.0	.0094	40.0	.0108	45.0	.0102
FS48340X29203	25	50.0	.0097	60.0	.0115	70.0	.0105	80.0	.0067	85.0	.0055
FS48340X29001	26		4 10	10.0	85.0	8	10.000	20.0	0.0		0.0
FS48340X29201	26	10.0	.0105	30.0	.0067	40.0	.0082	50.0	.0058	60.0	.0077
FS48340X29202	26	70.0	.005	80.0	.0064	85.0	.0073				
FS48340X29001	27		4 10	10.0	85.0	9	10.000	20.0	0.0		90.0

APPENDIX B

TABLE B-6. (CONTINUED)

FS48340X29201	27	10.0	.0094	20.0	.009	30.0	.0077	40.0	.0083	50.0	.0073
FS48340X29202	27	60.0	.0071	70.0	.0061	80.0	.0034	85.0	.0046		
FS48340X29001	28		5 10	61.2	180.0	11	10.000	20.0	0.0	20.0	
FS48340X29201	28	61.2	.0087	72.0	.0089	90.0	.0089	108.0	.0094	126.0	.0086
FS48340X29202	28	144.0	.0098	153.0	.0103	162.0	.0103	169.2	.0106	176.4	.0111
FS48340X29203	28	180.0	.012								
FS48340X29001	29		4 10	0.0	85.0	17	10.000	40.0	0.0		180.0
FS48340X29201	29	0.0	.0088	10.0	.0088	15.0	.0096	20.0	.0112	25.0	.0113
FS48340X29202	29	30.0	.0128	35.0	.0128	40.0	.0154	45.0	.0143	50.0	.0173
FS48340X29203	29	55.0	.0193	60.0	.0182	65.0	.0199	70.0	.0233	75.0	.0262
FS48340X29204	29	80.0	.0279	85.0	.0202						
FS48340X29001	30		4 10	10.0	85.0	8	10.000	40.0	0.0		0.0
FS48340X29201	30	10.0	.0085	20.0	.0089	30.0	.0084	50.0	.0075	60.0	.0105
FS48340X29202	30	70.0	.009	80.0	.0104	85.0	.0207				
FS48340X29001	31		4 10	15.0	85.0	9	10.000	40.0	0.0		90.0
FS48340X29201	31	15.0	.0084	20.0	.0093	30.0	.0086	40.0	.009	50.0	.0074
FS48340X29202	31	60.0	.0077	70.0	.0073	80.0	.0098	85.0	.005		
FS48340X29001	32		5 10	46.8	180.0	12	10.000	40.0	0.0	40.0	
FS48340X29201	32	46.8	.0092	54.0	.008	72.0	.0068	90.0	.0091	108.0	.0088
FS48340X29202	32	126.0	.0098	144.0	.0118	153.0	.0123	162.0	.0135	169.2	.0154
FS48340X29203	32	176.4	.0142	180.0	.0147						
FS48340X29001	33		4 10	0.0	85.0	15	10.000	60 0	0.0		180.0
FS48340X29201	33	0.0	.0079	10.0	.0087	20.0	.011	30.0	.0158	35.0	.018
FS48340X29202	33	40.0	.0222	45.0	.0281	50.0	.0359	55.0	.0459	60.0	.0588
FS48340X29203	33	65.0	.0738	70.0	.0884	75.0	.1076	80.0	.1202	85.0	.1073
FS48340X29001	34		4 10	10.0	85.0	8	10.000	60.0	0.0		0.0
FS48340X29201	34	10.0	.0071	20.0	.0078	30.0	.0073	40.0	.0103	50.0	.01
FS48340X29202	34	70.0	.0155	80.0	.0259	85.0	.0386				
FS48340X29001	35		4 10	20.0	85.0	8	10.000	60.0	0.0		90.0
FS48340X29201	35	20.0	.0072	30.0	.0067	40.0	.0047	50.0	.0061	60.0	.0078
FS48340X29202	35	70.0	.009	80.0	.0039	85.0	.0086				
FS48340X29001	36		5 10	46.8	180.0	12	10.000	60.0	0.0	60.0	
FS48340X29201	36	46.8	.0052	54.0	.0075	72.0	.0073	90.0	.0091	108.0	.0097
FS48340X29202	36	126.0	.0139	144.0	.0166	153.0	.0223	162.0	.0323	169.2	.0415
FS48340X29203	36	176.4	.0515	180.0	.054						

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APPENDIX C

SPECTRAL SCIENCES INC.
LEAF SAMPLE, TOP SIDE
FS4835:

INDEX TO APPENDIX C

PAGE NO.

DIRECTIONAL REFLECTANCE

INDEX TO APPENDIX C (continued)

PAGE NO.

DIRECTIONAL REFLECTANCE

BIDIRECTIONAL REFLECTANCE

INDEX TO APPENDIX C (continued)

PAGE NO.

BIDIRECTIONAL REFLECTANCE

INDEX TO APPENDIX C (continued)

PAGE NO.

BIDIRECTIONAL REFLECTANCE

SCATTERED TRANSMITTANCE

APPENDIX C

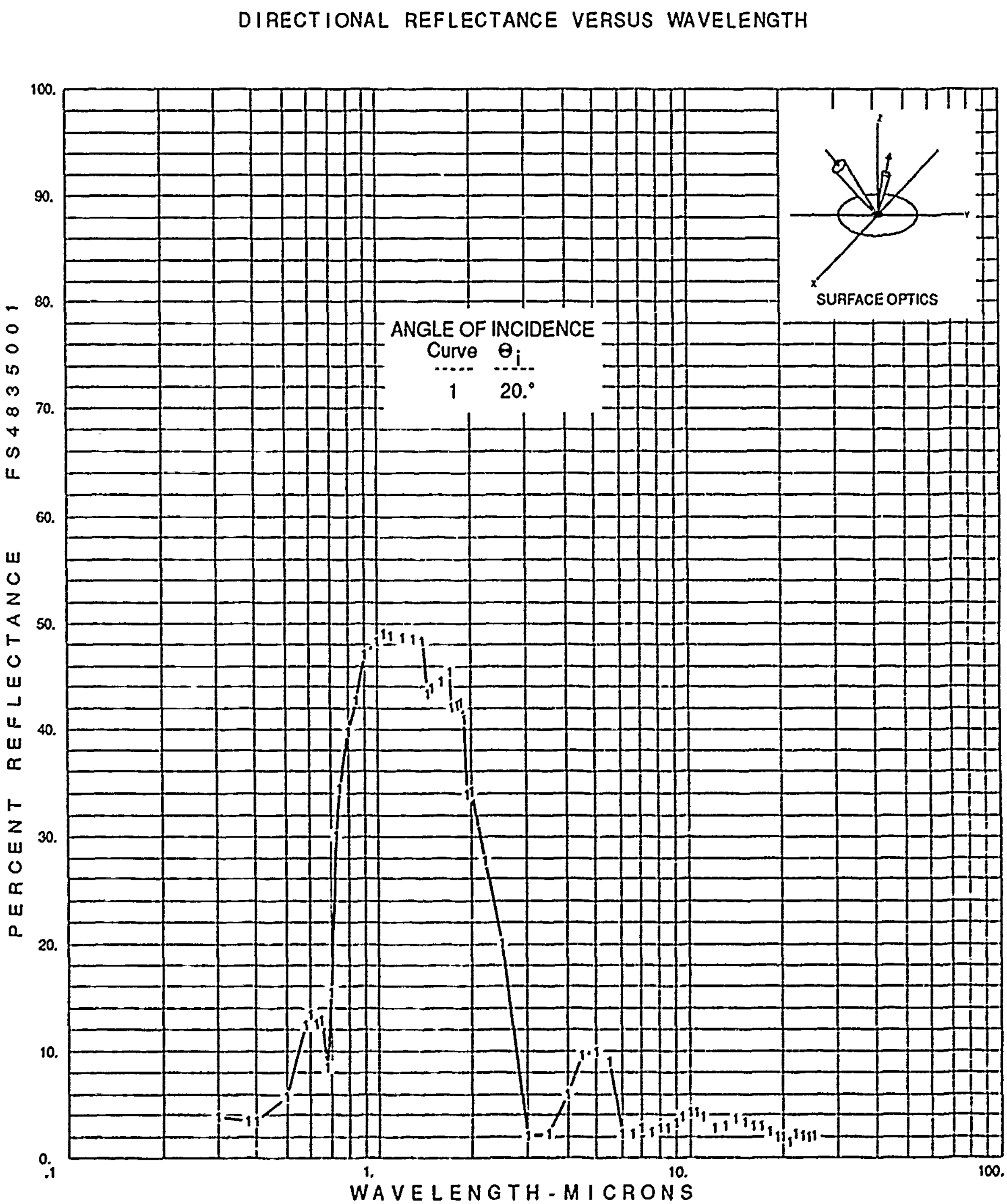

FIGURE C-1. SPECTRAL SCIENCES: LEAF SAMPLE, TOP SIDE
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 25.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX C

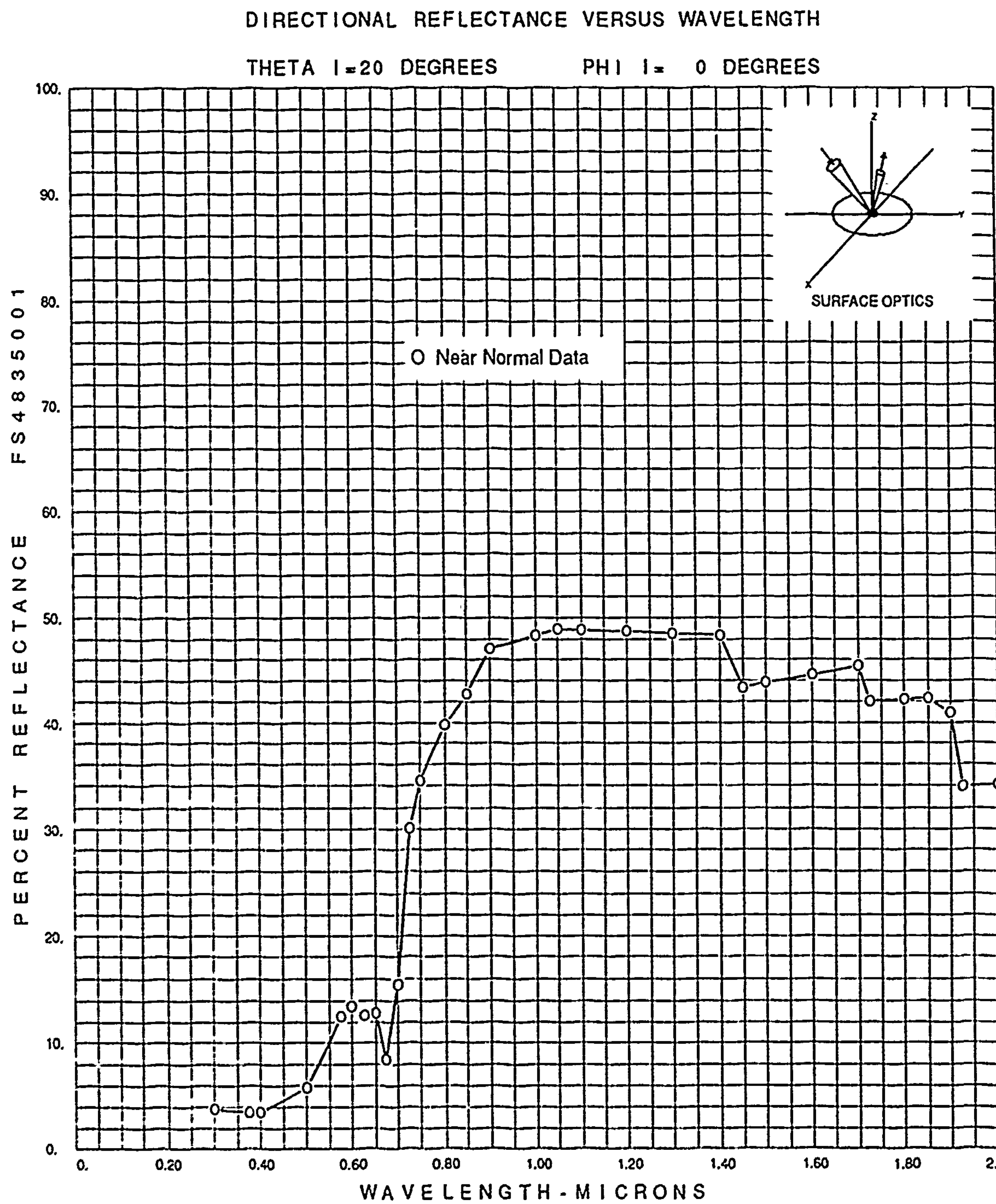

FIGURE C-2. SPECTRAL SCIENCES: LEAF SAMPLE, TOP SIDE
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 2.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

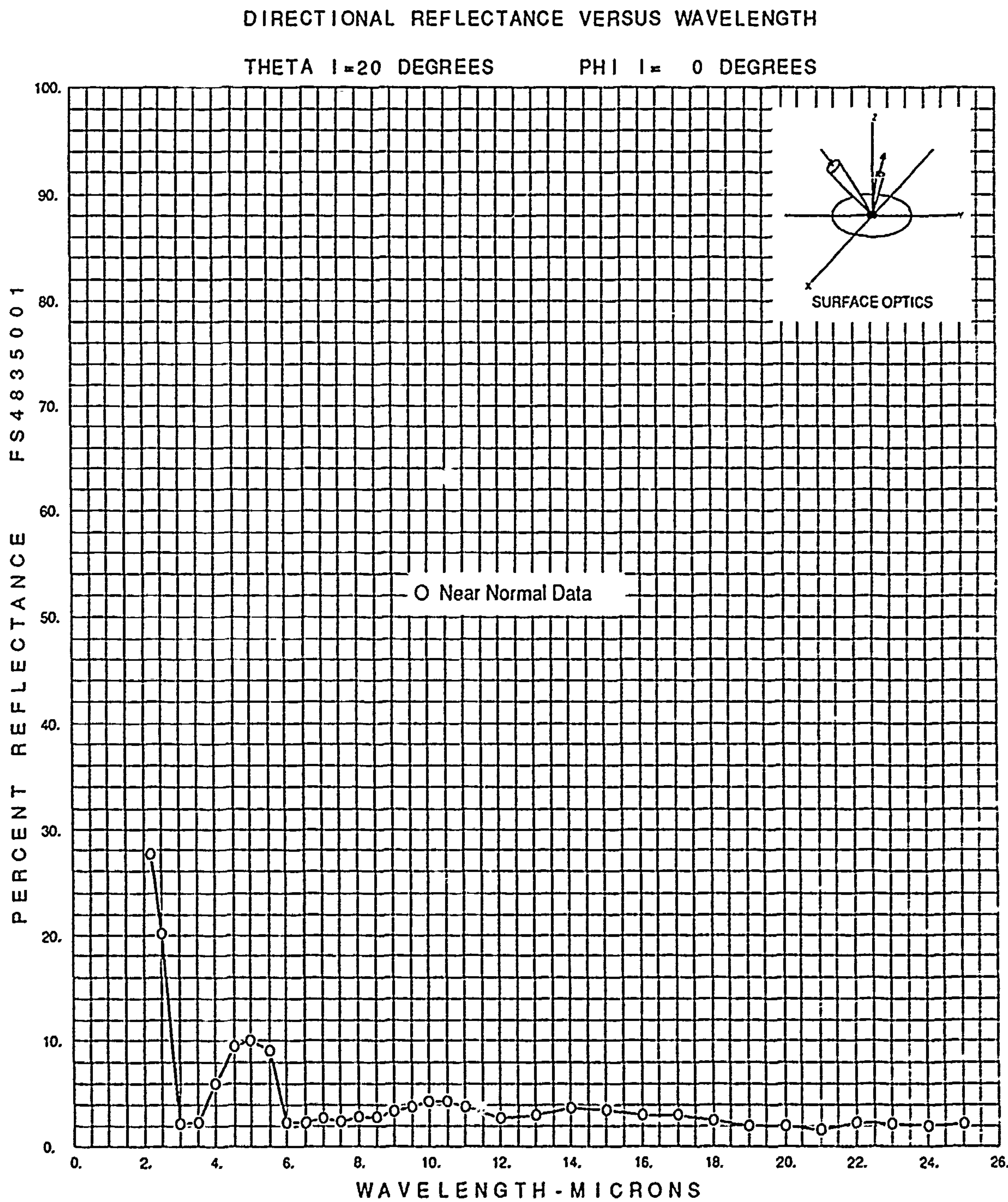

FIGURE C-3. SPECTRAL SCIENCES: LEAF SAMPLE, TOP SIDE
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 2.2 TO 25.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX C

TABLE C-1. SPECTRAL SCIENCES: LEAF SAMPLE, TOP SIDE. PHI = 0
DIRECTIONAL REFLECTANCE VS. WAVELENGTH - ERAS DATA
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

FS48350015001		1	1								
FS48350015101		SPECTRAL SCIENCES: LEAF SAMPLE, TOP SIDE									
FS48350015102		UNCORRECTED FOR INSTRUMENTATION POLARIZATION EFFECTS									
FS48350017001		101090									
FS48350019001	1	001	1	.3	25.	64				20.	0.
FS48350019201	1	.3	3.8	.375	3.5	.4	3.5	.5	5.8	.575	12.4
FS48350019202	1	.6	13.4	.625	12.6	.65	12.8	.675	8.5	.7	15.5
FS48350019203	1	.725	30.1	.75	34.5	.8	39.8	.85	42.7	.9	47.0
FS48350019204	1	1.	48.3	1.05	49.0	1.1	48.9	1.2	48.7	1.3	48.5
FS48350019205	1	1.4	48.3	1.45	43.4	1.5	43.8	1.6	44.6	1.7	45.4
FS48350019206	1	1.725	42.1	1.8	42.3	1.85	42.4	1.9	40.9	1.925	33.9
FS48350019207	1	2.	34.2	2.2	27.7	2.5	20.1	3.	2.1	3.5	2.3
FS48350019208	1	4.	6.0	4.5	9.5	5.	10.0	5.5	9.0	6.	2.3
FS48350019209	1	6.5	2.3	7.	2.7	7.5	2.4	8.	2.8	8.5	2.8
FS48350019210	1	9.	3.3	9.5	3.8	10.	4.3	10.5	4.3	11.	3.8
FS48350019211	1	12.	2.7	13.	3.0	14.	3.7	15.	3.4	16.	3.0
FS48350019212	1	17.	3.0	18.	2.5	19.	2.0	20.	2.0	21.	1.6
FS48350019213	1	22.	2.3	23.	2.1	24.	2.0	25.	2.1		

APPENDIX C

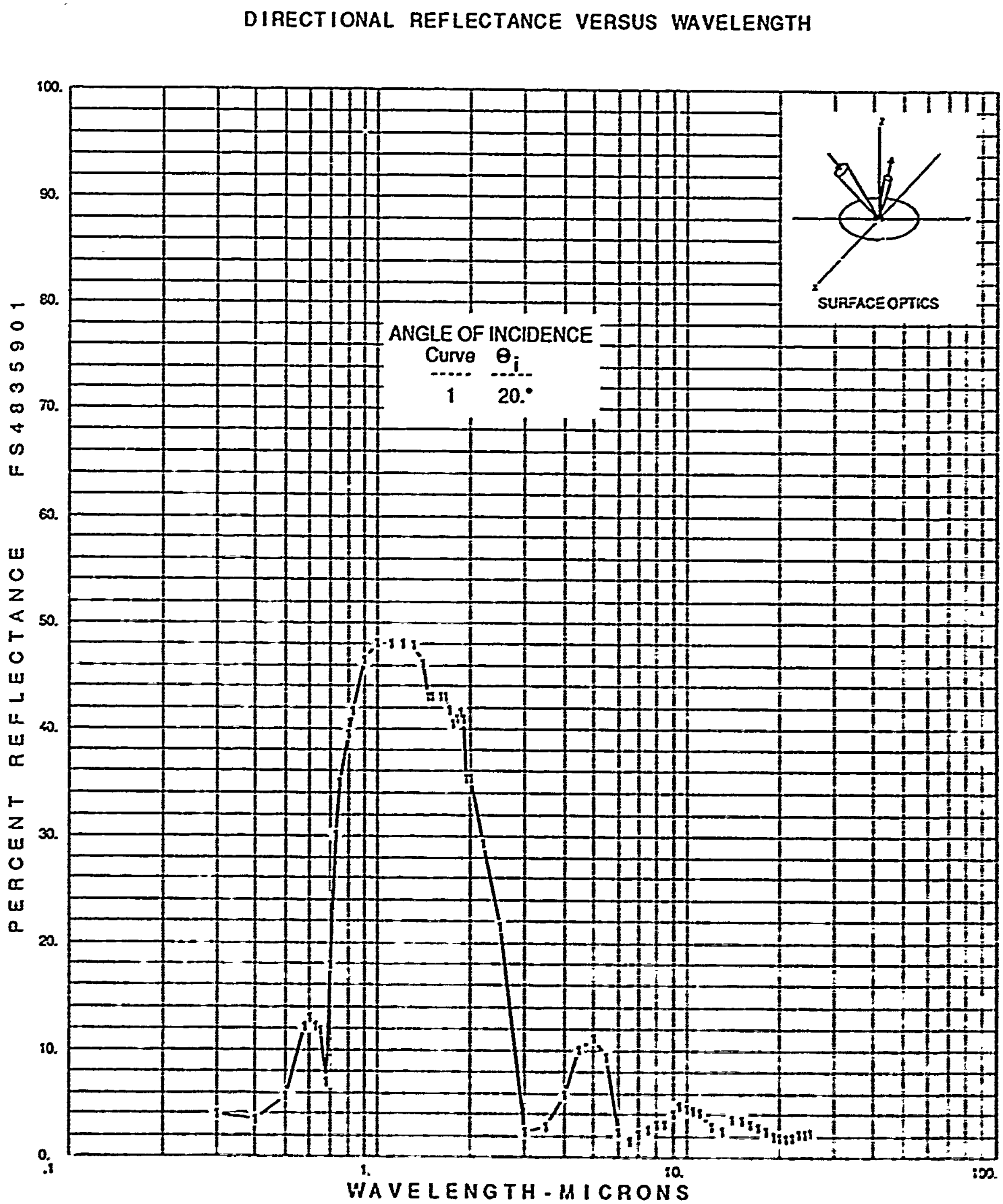

FIGURE C-4. SPECTRAL SCIENCES: LEAF SAMPLE,
TOP SIDE. PHI=90
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 25.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX C

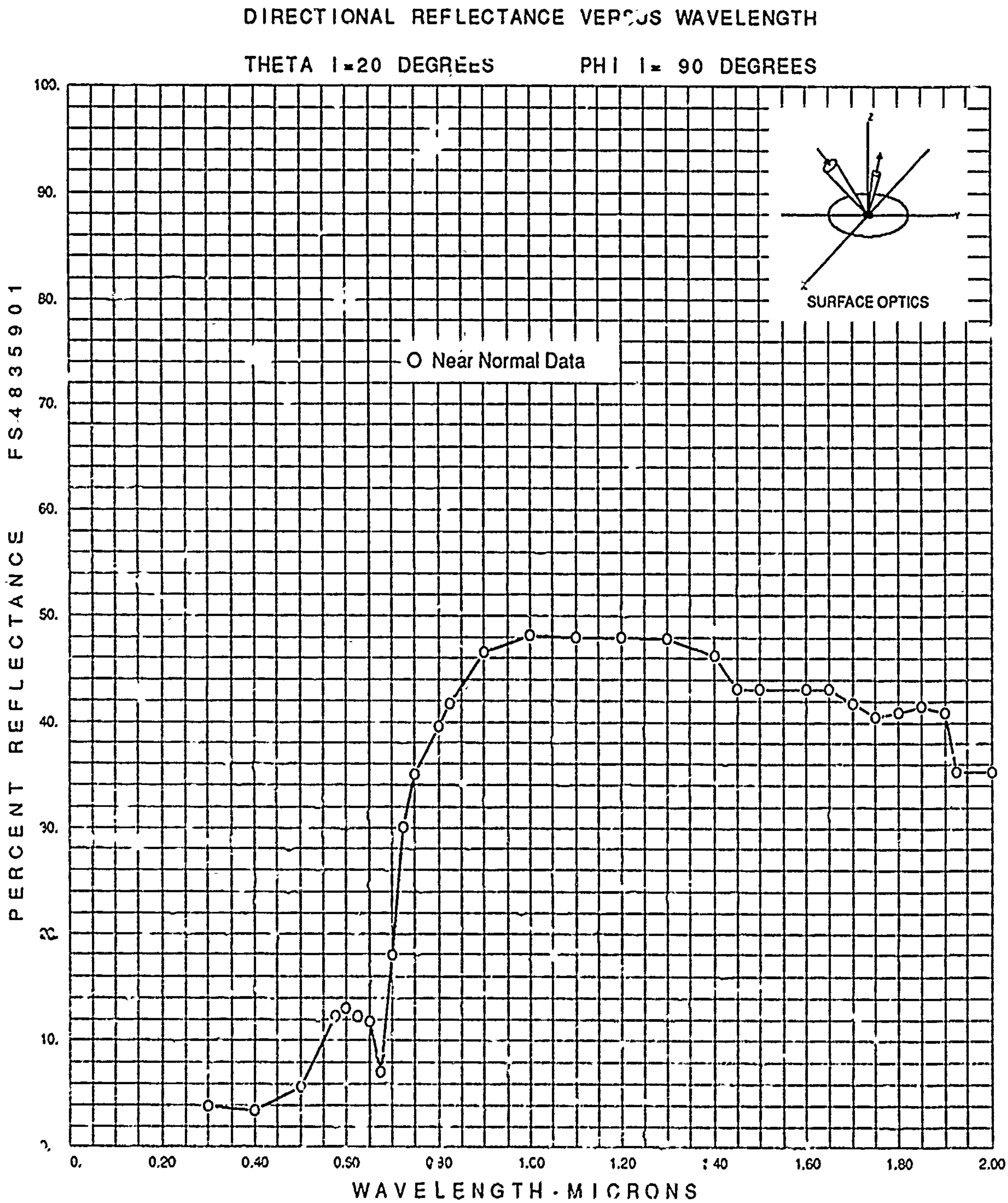

FIGURE C-5. SPECTRAL SCIENCES: LEAF SAMPLE,
TOP SIDE. PHI=90
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 2.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX C

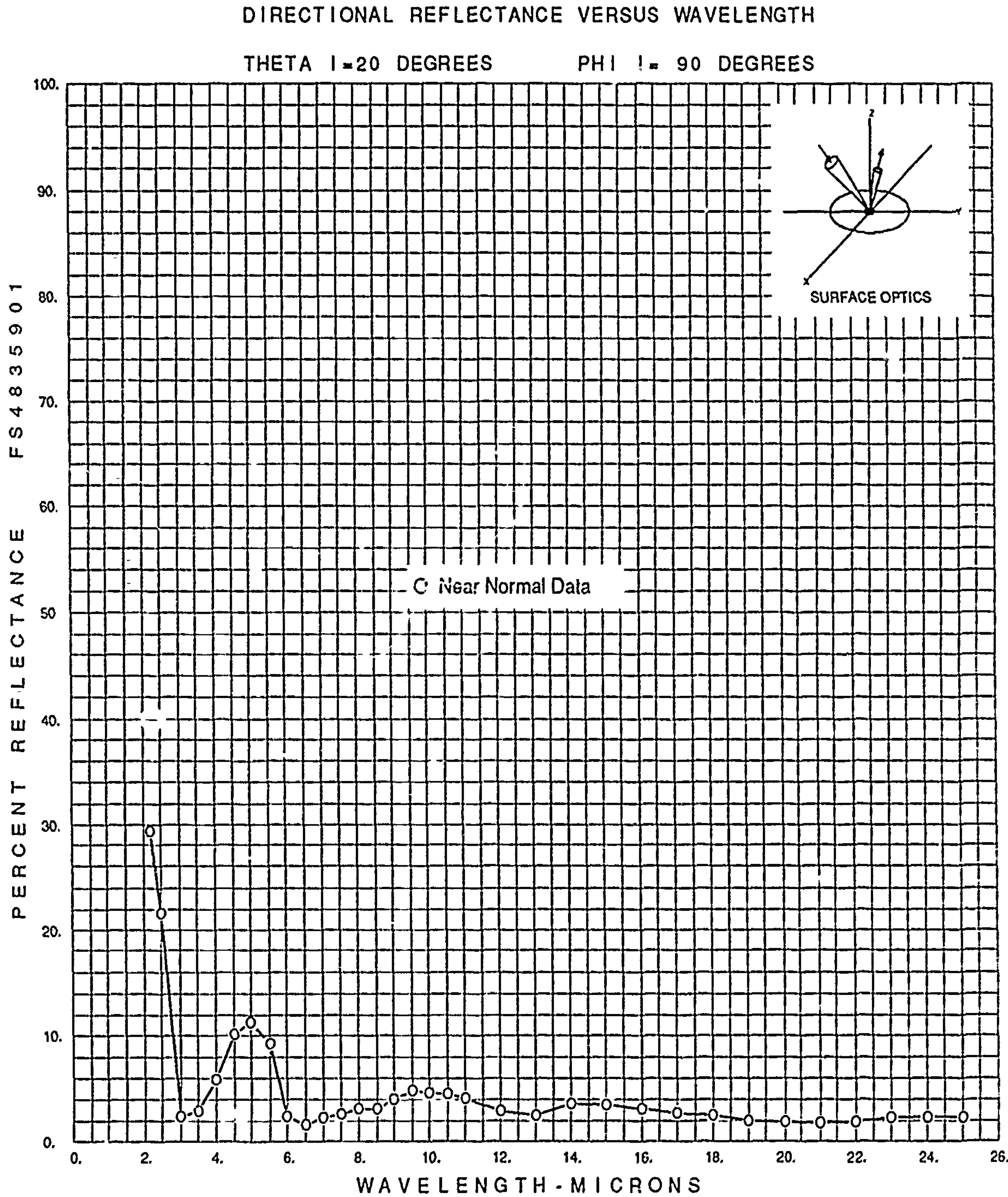

FIGURE C-6. SPECTRAL SCIENCES: LEAF SAMPLE,
TOP SIDE. PHI=90
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 2.2 TO 25.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX C

TABLE C-2. SPECTRAL SCIENCES: LEAF SAMPLE, TOP SIDE. PHI=90
DIRECTIONAL REFLECTANCE VS. WAVELENGTH - ERAS DATA
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

```
FS48359015001          1      1
FS48359015101       SPECTRAL SCIENCES: LEAF SAMPLE, TOP SIDE. PHI=90
FS48359015102       UNCORRECTED FOR INSTRUMENTATION POLARIZATION EFFECTS
FS48359017001       101090
FS48359019001   1         001  1      .3    25.   63                              20.      90.
FS48359019201   1      .3   3.9     .4    3.5     .5    5.7  .575   12.2     .6   13.0
FS48359019202   1    .625  12.2    .65   11.8   .675    7.1    .7   17.9   .725   30.1
FS48359019203   1     .75  35.0     .8   39.5   .825   41.7    .9   46.5     1.   48.1
FS48359019204   1     1.1  48.0    1.2   48.0    1.3   47.9   1.4   46.2   1.45   43.1
FS48359019205   1     1.5  43.1    1.6   43.1   1.65   43.1   1.7   41.8   1.75   40.5
FS48359019206   1     1.8  41.0   1.85   41.5    1.9   40.9 1.925   35.4     2.   35.4
FS48359019207   1     2.2  29.3    2.5   21.5     3.    2.4   3.5    2.9     4.    5.9
FS48359019208   1     4.5  10.1     5.   11.2    5.5    9.3    6.    2.4    6.5    1.6
FS48359019209   1      7.   2.2    7.5    2.6     8.    3.1   8.5    3.1     9.    4.0
FS48359019210   1     9.5   4.8    10.    4.6   10.5    4.4   11.    4.1    12.    2.9
FS48359019211   1     13.   2.5    14.    3.6    15.    3.5   16.    3.1    17.    2.7
FS48359019212   1     18.   2.5    19.    2.0    20.    1.9   21.    1.8    22.    1.9
FS48359019213   1     23.   2.2    24.    2.2    25.    2.3
```

APPENDIX C

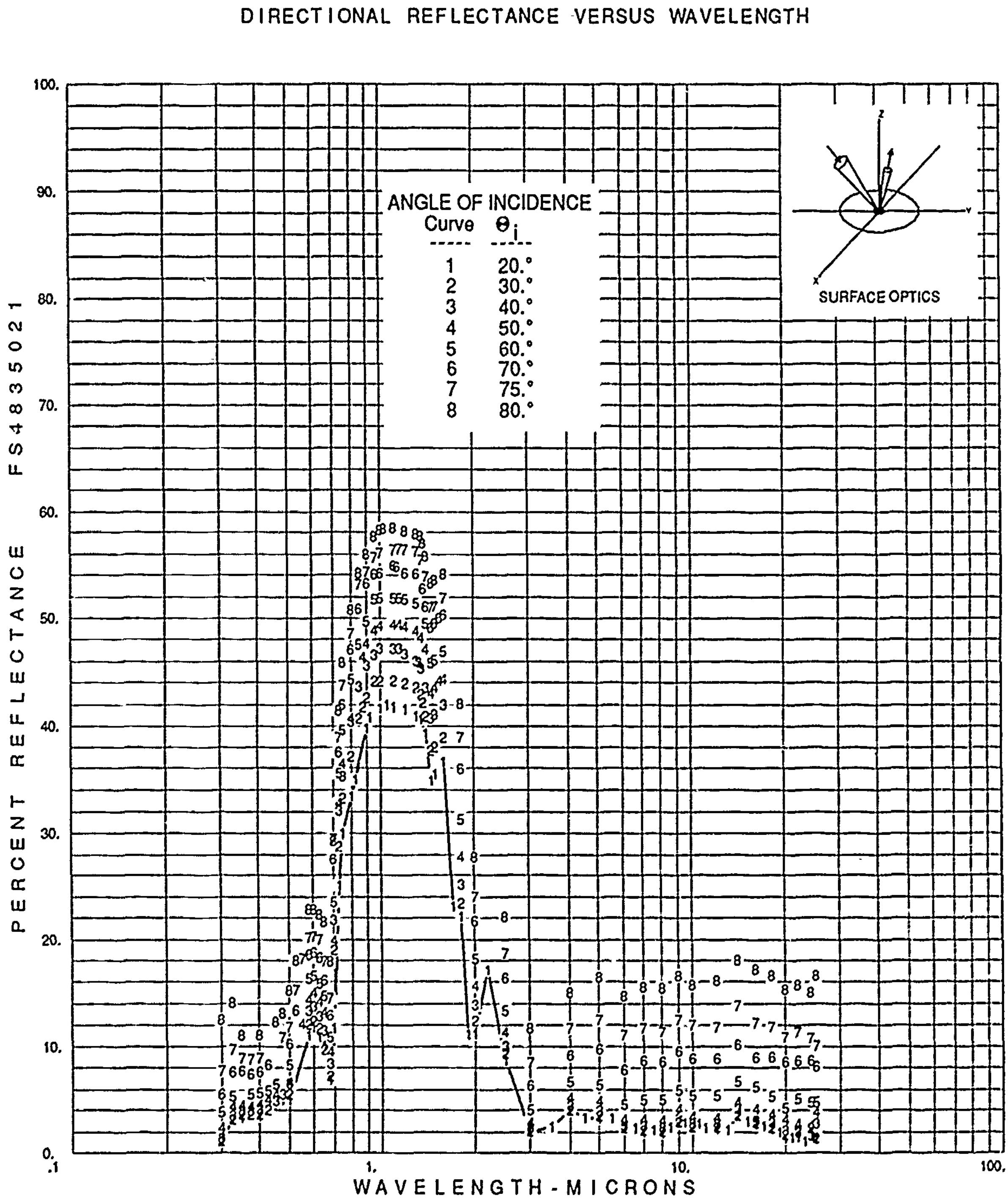

FIGURE C-7. SPECTRAL SCIENCES: LEAF SAMPLE, TOP SIDE
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 25.0 MICROMETERS
DATA CORRECTED FOR INSTRUMENTATION POLARIZATION
DATA FROM 0.3 TO 1.6 MICROMETERS MEASURED
AFTER DATA FROM 1.6 TO 25.0 MICROMETERS

APPENDIX C

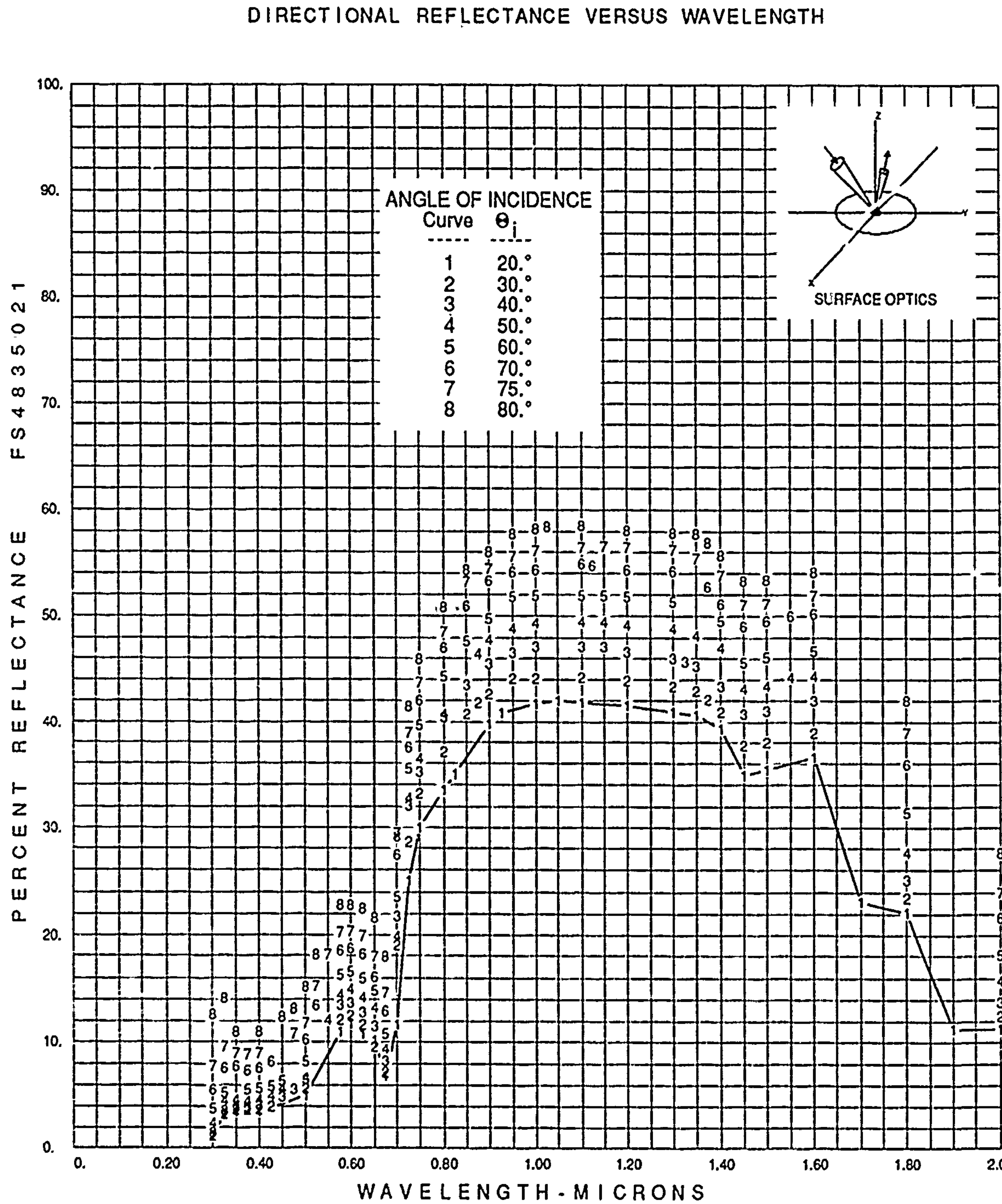

FIGURE C-8. SPECTRAL SCIENCES: LEAF SAMPLE, TOP SIDE
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 2.0 MICROMETERS
DATA CORRECTED FOR INSTRUMENTATION POLARIZATION
DATA FROM 0.3 TO 1.6 MICROMETERS MEASURED
AFTER DATA FROM 1.6 TO 25.0 MICROMETERS

APPENDIX C

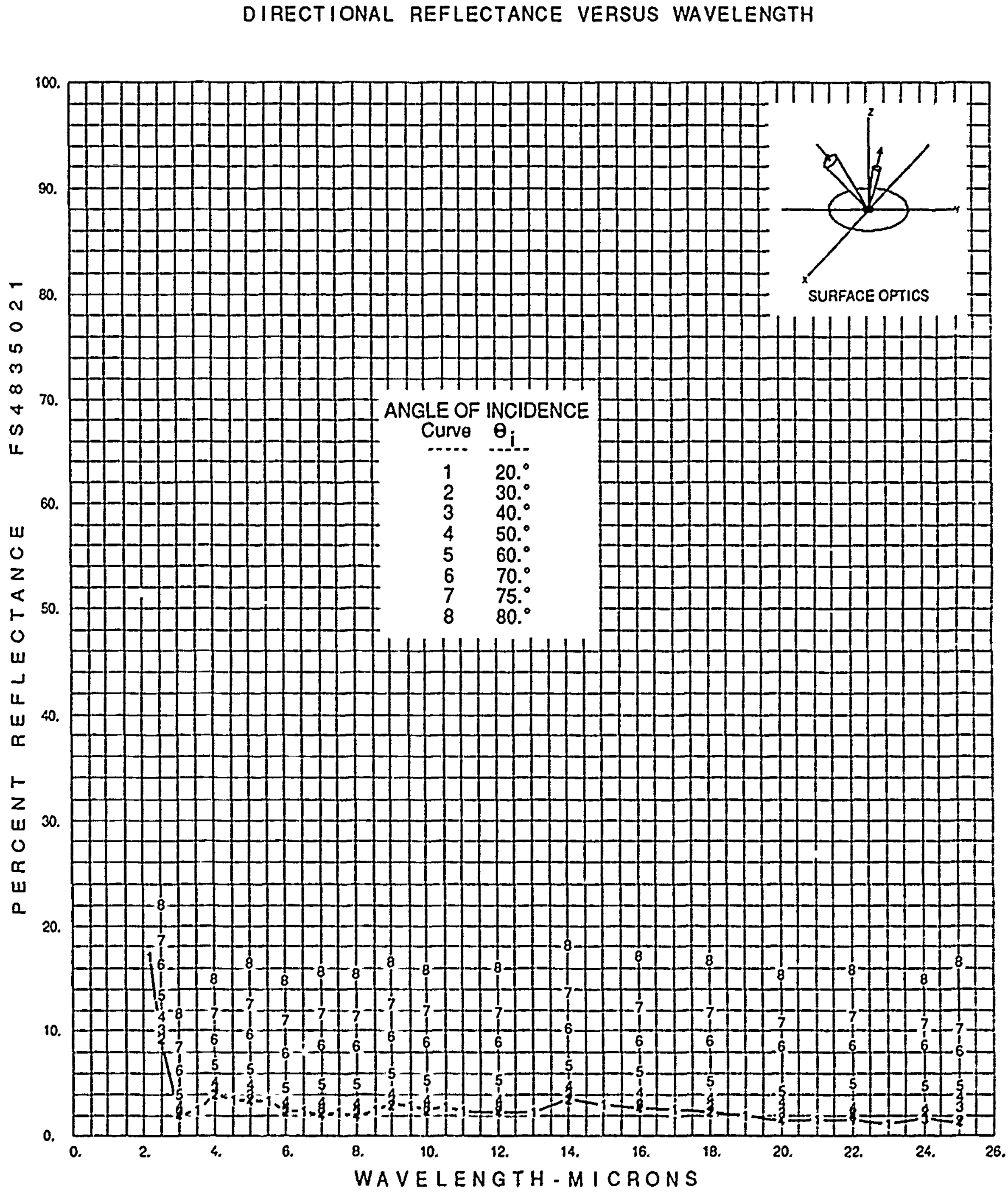

FIGURE C-9. SPECTRAL SCIENCES: LEAF SAMPLE, TOP SIDE
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 2.2 TO 25.0 MICROMETERS
DATA CORRECTED FOR INSTRUMENTATION POLARIZATION
DATA FROM 0.3 TO 1.6 MICROMETERS MEASURED
AFTER DATA FROM 1.6 TO 25.0 MICROMETERS

APPENDIX C

TABLE C-3. SPECTRAL SCIENCES: LEAF SAMPLE, TOP SIDE. PHI = 0
DIRECTIONAL REFLECTANCE VS. WAVELENGTH - ERAS DATA
DATA CORRECTED FOR INSTRUMENTATION POLARIZATION
DATA FROM 0.3 TO 1.6 MICROMETERS MEASURED
AFTER DATA FROM 1.6 TO 25.0 MICROMETERS

FS48350215001		8	1								
FS48350215101		SPECTRAL SCIENCES: LEAF SAMPLE, TOP SIDE									
FS48350215102		CORRECTED FOR INSTRUMENTATION POLARIZATION EFFECTS									
FS48350217001		092890									
FS48350219001	1	001	1	.3	25.	64				20.	0.
FS48350219201	1	.3	1.2	.325	3.2	.35	3.4	.4	3.5	.5	5.0
FS48350219202	1	.575	11.0	.6	11.8	.625	10.8	.65	10.1	.675	6.9
FS48350219203	1	.7	11.7	.725	25.1	.75	30.0	.8	33.5	.825	35.0
FS48350219204	1	.9	39.8	.925	40.8	1.	41.7	1.05	42.0	1.1	41.8
FS48350219205	1	1.2	41.5	1.3	40.9	1.35	40.6	1.4	39.3	1.45	34.9
FS48350219206	1	1.5	35.5	1.6	36.7	1.7	23.1	1.8	22.1	1.9	11.2
FS48350219207	1	2.	11.2	2.2	17.1	2.5	8.7	3.	2.0	3.5	2.5
FS48350219208	1	4.	4.0	4.5	3.4	5.	3.3	5.5	3.3	6.	2.4
FS48350219209	1	6.5	2.4	7.	2.0	7.5	2.2	8.	1.9	8.5	2.5
FS48350219210	1	9.	3.1	9.5	2.9	10.	2.6	10.5	2.8	11.	2.4
FS48350219211	1	12.	2.3	13.	2.2	14.	3.6	15.	3.0	16.	2.7
FS48350219212	1	17.	2.6	18.	2.3	19.	2.0	20.	1.5	21.	1.6
FS48350219213	1	22.	1.6	23.	1.1	24.	1.8	25.	1.3		
FS48350219001	2	001	1	.3	25.	49				30.	0.
FS48350219201	2	.3	1.1	.325	3.2	.35	3.7	.375	3.7	.4	3.7
FS48350219202	2	.425	4.0	.5	5.6	.575	12.1	.6	12.4	.625	11.7
FS48350219203	2	.65	9.6	.675	7.2	.7	19.0	.725	28.7	.75	33.2
FS48350219204	2	.8	37.1	.85	40.7	.875	41.8	.9	42.6	.95	44.1
FS48350219205	2	1.	44.1	1.1	44.2	1.2	43.9	1.3	43.5	1.35	42.9
FS48350219206	2	1.375	42.2	1.4	40.9	1.45	37.8	1.5	38.0	1.6	39.0
FS48350219207	2	1.8	23.4	2.	12.4	2.5	9.3	3.	2.1	4.	4.0
FS48350219208	2	5.	3.6	6.	2.4	7.	2.2	8.	2.1	9.	3.0
FS48350219209	2	10.	2.5	12.	2.5	14.	3.6	16.	2.9	18.	2.4
FS48350219210	2	20.	1.8	22.	2.2	24.	2.4	25.	1.5		
FS48350219001	3	001	1	.3	25.	50				40.	0.
FS48350219201	3	.3	1.5	.325	3.6	.35	3.9	.375	3.9	.4	4.1
FS48350219202	3	.45	4.9	.475	5.5	.5	6.5	.575	13.4	.6	13.7
FS48350219203	3	.625	12.8	.65	11.5	.675	8.3	.7	21.8	.725	32.1
FS48350219204	3	.75	35.3	.8	40.4	.85	43.6	.9	45.6	.95	46.6
FS48350219205	3	1.	47.1	1.1	47.1	1.15	47.1	1.2	46.7	1.3	46.0
FS48350219206	3	1.325	45.8	1.35	45.3	1.4	43.5	1.45	40.7	1.5	41.1
FS48350219207	3	1.6	42.0	1.8	25.2	2.	13.8	2.5	10.1	3.	2.4
FS48350219208	3	4.	4.5	5.	4.0	6.	2.6	7.	2.6	8.	2.4
FS48350219209	3	9.	3.4	10.	2.8	12.	2.8	14.	4.1	16.	3.1
FS48350219210	3	18.	2.9	20.	2.2	22.	2.0	24.	1.7	25.	2.8
FS48350219001	4	001	1	.3	25.	51				50.	0.
FS48350219201	4	.3	2.4	.325	4.4	.35	4.5	.375	4.4	.4	4.6
FS48350219202	4	.425	5.0	.45	5.6	.5	6.6	.55	12.1	.575	14.4
FS48350219203	4	.6	15.0	.625	14.2	.65	13.2	.675	9.4	.7	19.9
FS48350219204	4	.725	32.7	.75	36.5	.8	40.7	.875	46.4	.9	47.7
FS48350219205	4	.95	48.9	1.	49.3	1.1	49.4	1.15	49.4	1.2	49.2
FS48350219206	4	1.3	48.8	1.35	48.1	1.4	47.0	1.45	43.1	1.5	43.5
FS48350219207	4	1.55	44.2	1.6	44.3	1.8	27.7	2.	15.7	2.5	11.4

APPENDIX C

TABLE C-3. (CONTINUED)

FS48350219208	4	3.	2.9	4.	5.2	5.	4.9	6.	3.2	7.	3.2
FS48350219209	4	8.	3.1	9.	4.1	10.	3.5	12.	3.4	14.	4.8
FS48350219210	4	16.	4.2	18.	3.7	20.	3.2	22.	2.8	24.	2.6
FS48350219211	4	25.	3.8								
FS48350219001	5	001	1	.3	25.	47				60.	0.
FS48350219201	5	.3	3.8	.325	5.3	.375	5.5	.4	5.7	.425	5.9
FS48350219202	5	.45	6.4	.5	8.2	.575	16.3	.6	16.6	.625	15.9
FS48350219203	5	.65	14.7	.675	10.8	.7	23.5	.725	35.6	.75	39.6
FS48350219204	5	.8	44.3	.85	47.6	.9	49.7	.95	51.8	1.	51.9
FS48350219205	5	1.1	51.9	1.15	51.9	1.2	51.8	1.3	51.4	1.4	49.5
FS48350219206	5	1.45	45.7	1.5	46.1	1.6	46.8	1.8	31.3	2.	18.2
FS48350219207	5	2.5	13.4	3.	4.0	4.	6.7	5.	6.4	6.	4.6
FS48350219208	5	7.	5.0	8.	5.0	9.	6.0	10.	5.4	12.	5.4
FS48350219209	5	14.	6.7	16.	6.2	18.	5.3	20.	4.3	22.	5.1
FS48350219210	5	24.	4.8	25.	4.8						
FS48350219001	6	001	1	.3	25.	50				70.	0.
FS48350219201	6	.3	5.5	.325	7.6	.35	7.7	.375	7.4	.4	7.6
FS48350219202	6	.425	8.2	.5	10.3	.525	13.4	.575	18.6	.6	18.8
FS48350219203	6	.625	18.3	.65	16.1	.675	12.9	.7	27.5	.725	37.5
FS48350219204	6	.75	42.0	.8	47.0	.85	50.9	.9	53.3	.95	54.1
FS48350219205	6	1.	54.3	1.1	54.9	1.125	54.8	1.2	54.3	1.3	54.2
FS48350219206	6	1.375	52.7	1.4	51.1	1.45	49.1	1.5	49.5	1.55	50.0
FS48350219207	6	1.6	50.3	1.8	35.9	2.	21.7	2.5	16.4	3.	6.3
FS48350219208	6	4.	9.2	5.	9.7	6.	7.8	7.	8.7	8.	8.6
FS48350219209	6	9.	9.5	10.	8.9	12.	8.9	14.	10.2	16.	9.0
FS48350219210	6	18.	9.0	20.	8.6	22.	8.7	24.	8.7	25.	8.1
FS48350219001	7	001	1	.3	25.	50				75.	0.
FS48350219201	7	.3	7.7	.325	9.6	.35	8.9	.375	8.8	.4	8.9
FS48350219202	7	.475	10.8	.5	11.8	.525	15.3	.55	18.2	.575	20.2
FS48350219203	7	.6	20.3	.625	20.0	.65	17.9	.675	14.5	.7	29.4
FS48350219204	7	.725	39.0	.75	43.7	.8	48.5	.85	53.2	.9	54.4
FS48350219205	7	.95	55.7	1.	56.1	1.1	56.4	1.15	56.5	1.2	56.4
FS48350219206	7	1.3	56.2	1.35	55.4	1.4	53.8	1.45	51.0	1.5	51.1
FS48350219207	7	1.6	51.9	1.8	39.0	2.	24.0	2.5	18.7	3.	8.5
FS48350219208	7	4.	11.7	5.	12.5	6.	11.0	7.	11.7	8.	11.4
FS48350219209	7	9.	12.6	10.	12.0	12.	11.8	14.	13.7	16.	12.2
FS48350219210	7	18.	11.8	20.	10.8	22.	11.4	24.	10.7	25.	10.1
FS48350219001	8	001	1	.3	25.	50				80.	0.
FS48350219201	8	.3	12.5	.325	14.1	.35	11.0	.4	11.0	.45	12.3
FS48350219202	8	.475	13.1	.5	15.2	.525	18.1	.575	22.8	.6	22.8
FS48350219203	8	.625	22.4	.65	21.6	.675	17.9	.7	29.1	.725	41.4
FS48350219204	8	.75	45.9	.8	50.8	.85	54.3	.9	56.0	.95	57.7
FS48350219205	8	1.	58.2	1.025	58.4	1.1	58.5	1.2	58.1	1.3	57.8
FS48350219206	8	1.35	57.7	1.375	57.0	1.4	55.8	1.45	53.3	1.5	53.5
FS48350219207	8	1.6	54.1	1.8	42.1	2.	27.7	2.5	22.1	3.	11.7
FS48350219208	8	4.	15.0	5.	16.5	6.	14.7	7.	15.6	8.	15.5
FS48350219209	8	9.	16.6	10.	15.8	12.	16.1	14.	18.1	16.	17.2
FS48350219210	8	18.	16.7	20.	15.4	22.	15.8	24.	15.0	25.	16.6

APPENDIX C

TABLE C-4. SPECTRAL SCIENCES: LEAF SAMPLE, TOP SIDE
DIRECTIONAL EMITTANCE AS A FUNCTION OF TEMPERATURE
DATA CORRECTED FOR INSTRUMENTATION POLARIZATION
DATA CORRECTED FOR MATERIAL TRANSMISSION

FS4835021: SPECTRAL SCIENCES: LEAF SAMPLE, TOP SIDE
CORRECTED FOR INSTRUMENTATION POLARIZATION EFFECTS

Emittance tabulated as a function of temperature:

Zenith angle (degrees)	Wavelength range (microns)	Temperature (degrees Kelvin) 100	200	300	400	500	600
20	0.300 - 25.000	0.981	0.975	0.968	0.955	0.941	0.927

DATA CORRECTED FOR MATERIAL TRANSMISSION

APPENDIX C

TABLE C-5. SPECTRAL SCIENCES: LEAF SAMPLE, TOP SIDE
SOLAR ABSORPTANCE
DATA CORRECTED FOR INSTRUMENTATION POLARIZATION
DATA CORRECTED FOR MATERIAL TRANSMISSION

```
FS4835021                                    Surface Optics Corp.
SPECTRAL SCIENCES: LEAF SAMPLE, TOP SIDE

20 degrees: The exoatmospheric solar absorptance is 0.544.

DATA CORRECTED FOR MATERIAL TRANSMISSION
```

APPENDIX C

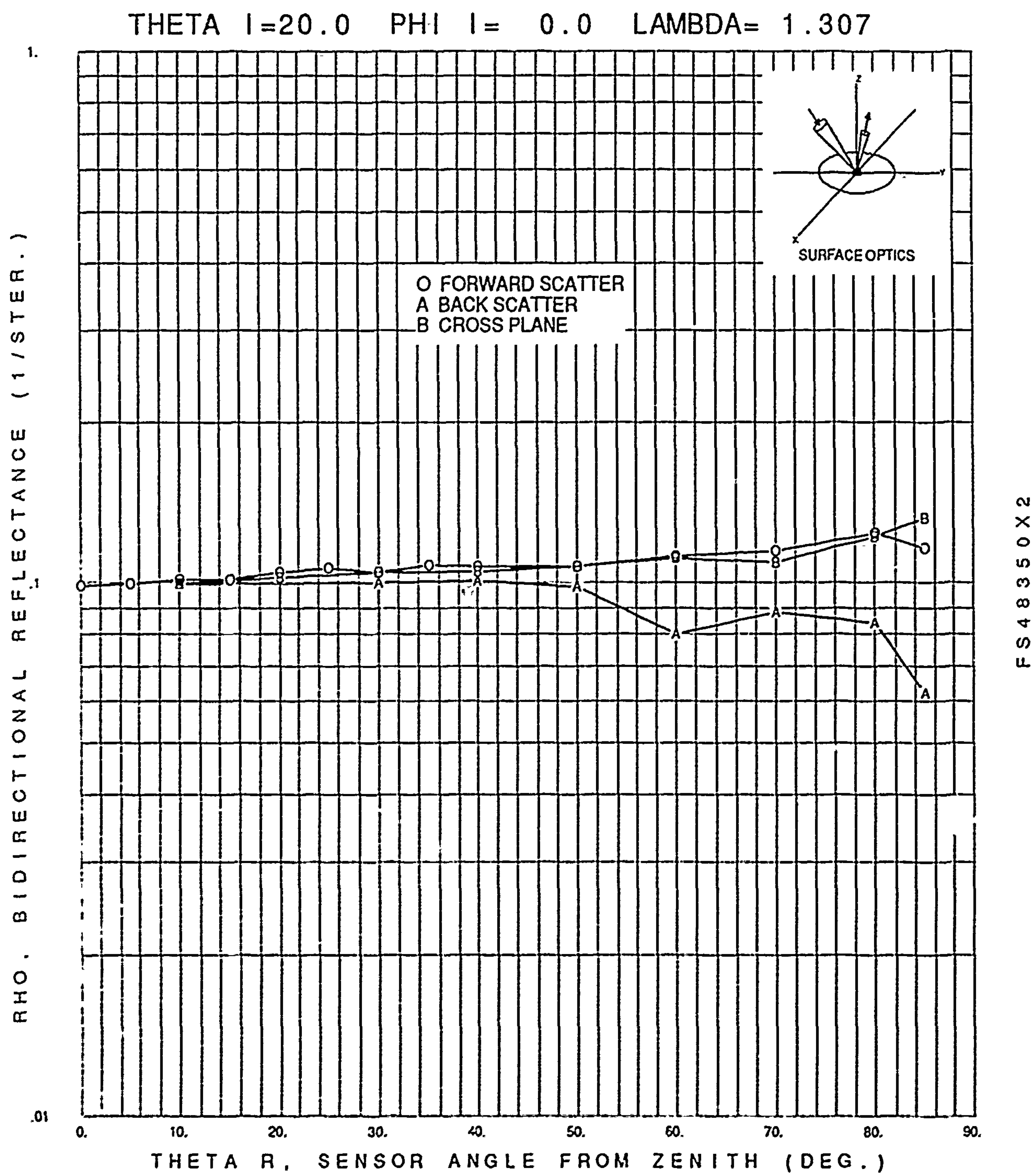

FIGURE C-10. SPECTRAL SCIENCES: LEAF SAMPLE, TOP SIDE
BIDIRECTIONAL REFLECTANCE VS. REFLECTED POLAR ANGLE
WAVELENGTH 1.307 MICROMETERS
INCIDENT POLAR ANGLE 20.0 DEGREES

APPENDIX C

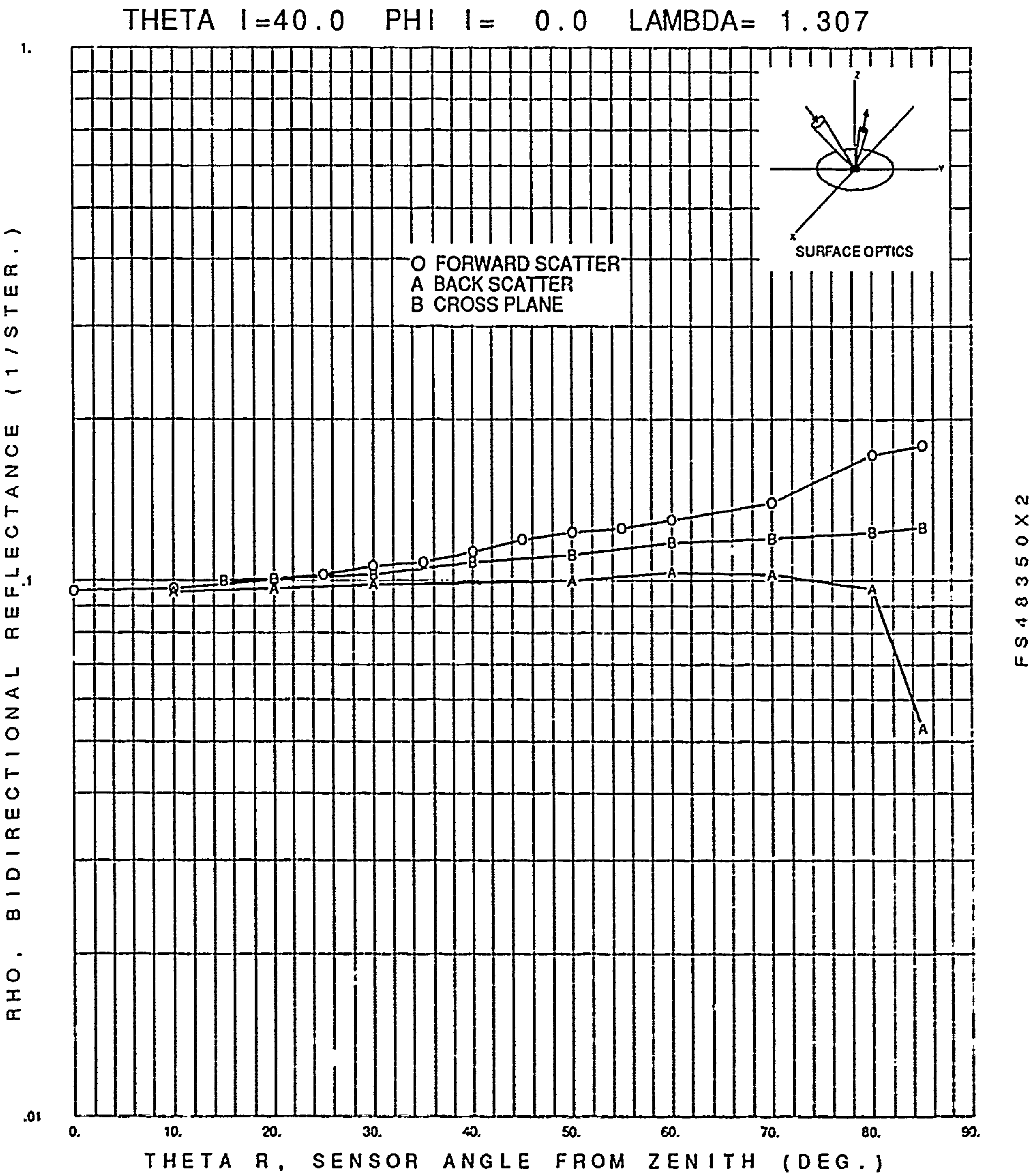

FIGURE C-11. SPECTRAL SCIENCES: LEAF SAMPLE, TOP SIDE
BIDIRECTIONAL REFLECTANCE VS. REFLECTED POLAR ANGLE
WAVELENGTH 1.307 MICROMETERS
INCIDENT POLAR ANGLE 40.0 DEGREES

APPENDIX C

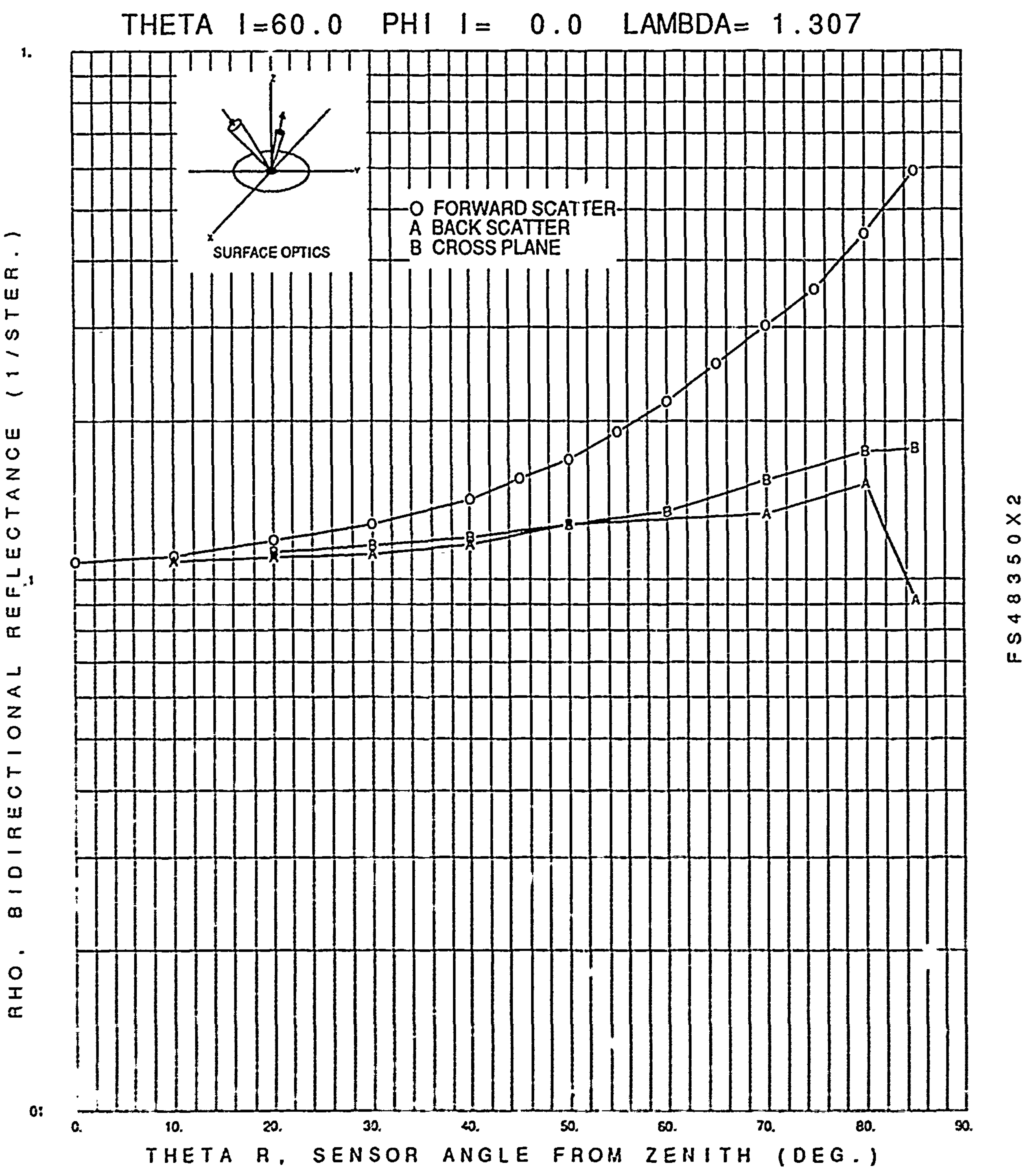

FIGURE C-12. SPECTRAL SCIENCES: LEAF SAMPLE, TOP SIDE
BIDIRECTIONAL REFLECTANCE VS. REFLECTED POLAR ANGLE
WAVELENGTH 1.307 MICROMETERS
INCIDENT POLAR ANGLE 60.0 DEGREES

APPENDIX C

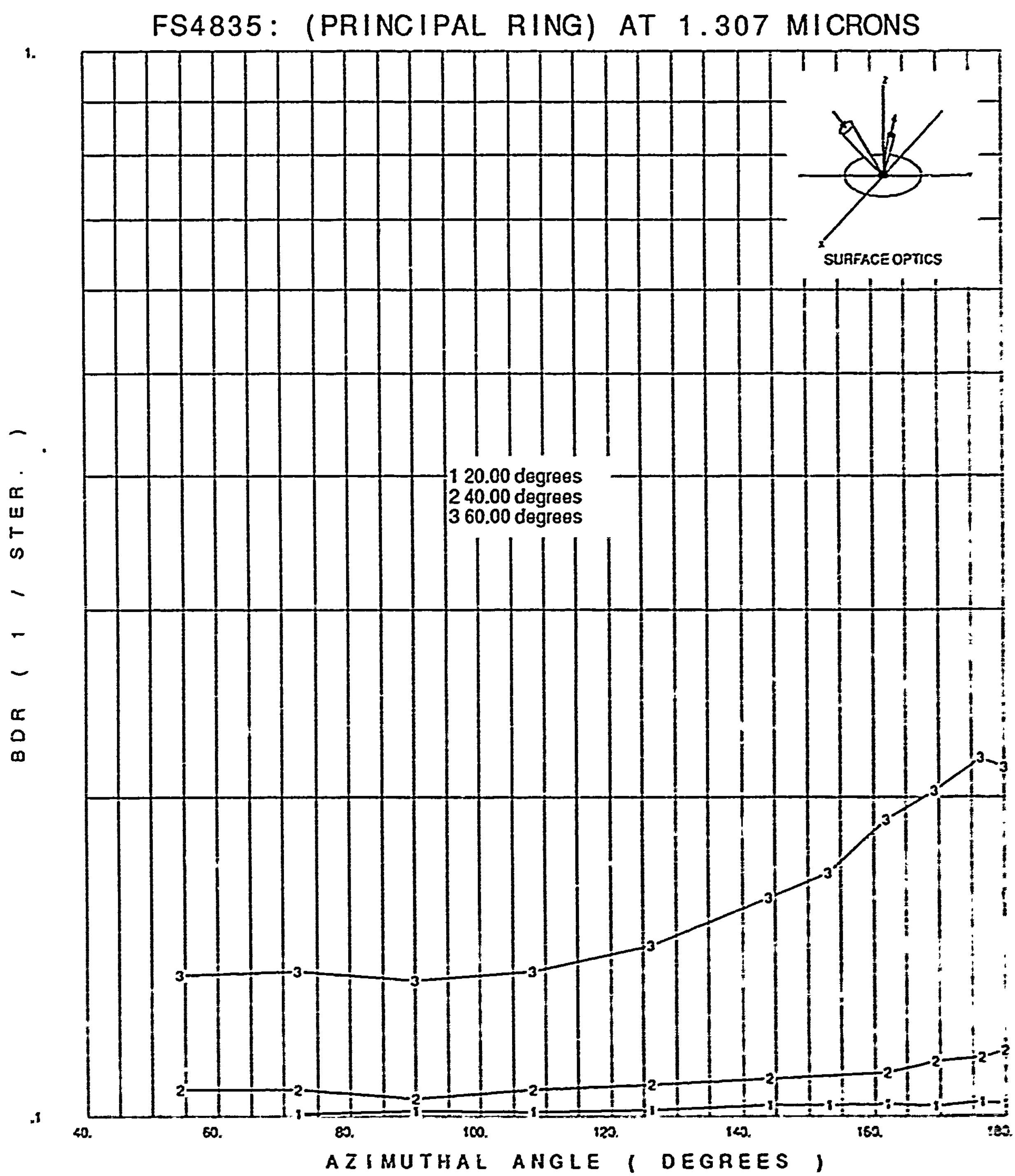

FIGURE C-13. SPECTRAL SCIENCES: LEAF SAMPLE, TOP SIDE
BIDIRECTIONAL REFLECTANCE VS. REFLECTED AZIMUTH ANGLE
PRINCIPAL RING AT 1.307 MICROMETERS
INCIDENT POLAR ANGLES 20, 40 AND 60 DEGREES

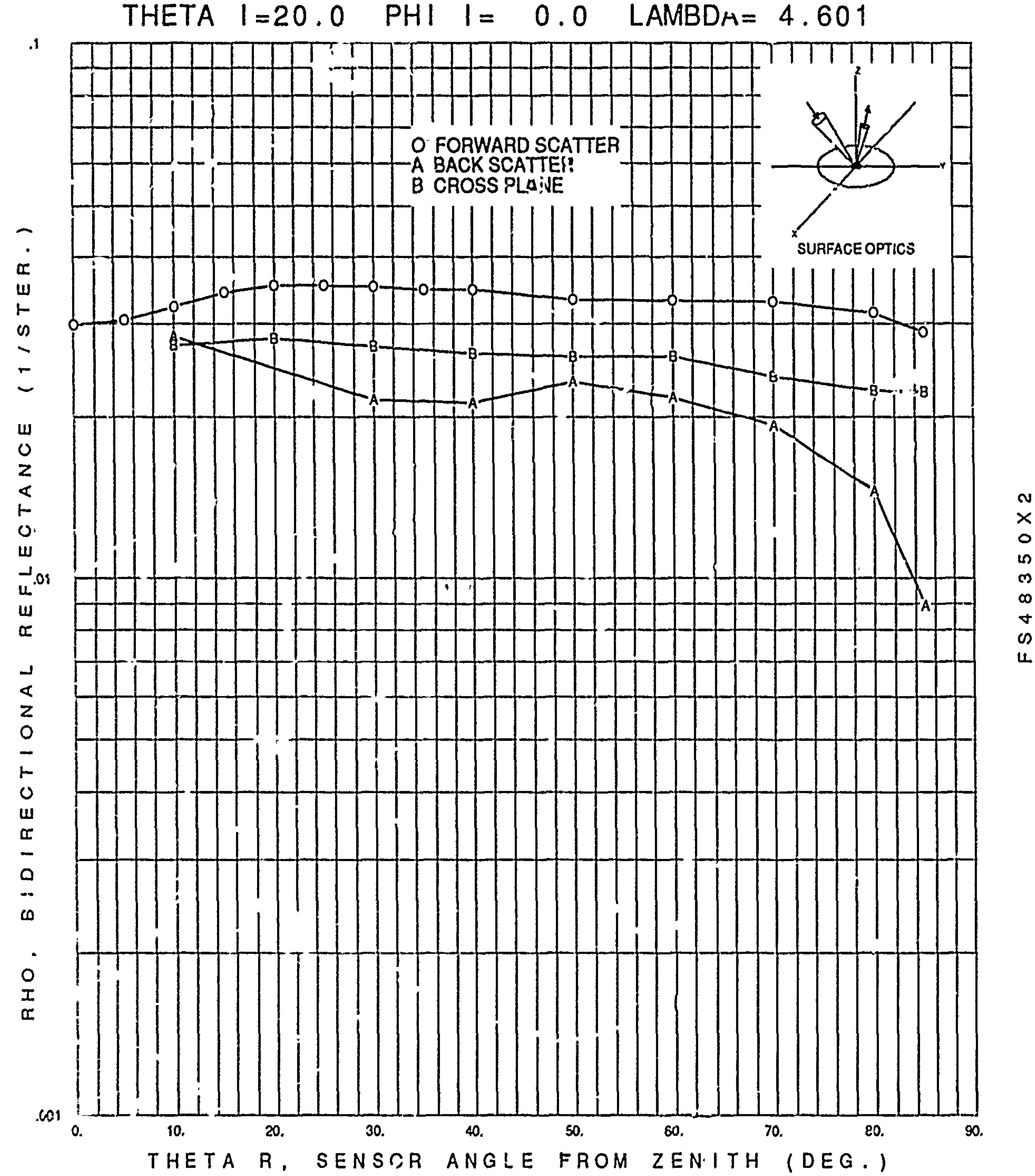

FIGURE C-14. SPECTRAL SCIENCES: LEAF SAMPLE, TOP SIDE
BIDIRECTIONAL REFLECTANCE VS. REFLECTED POLAR ANGLE
WAVELENGTH 4.601 MICROMETERS
INCIDENT POLAR ANGLE 20.0 DEGREES

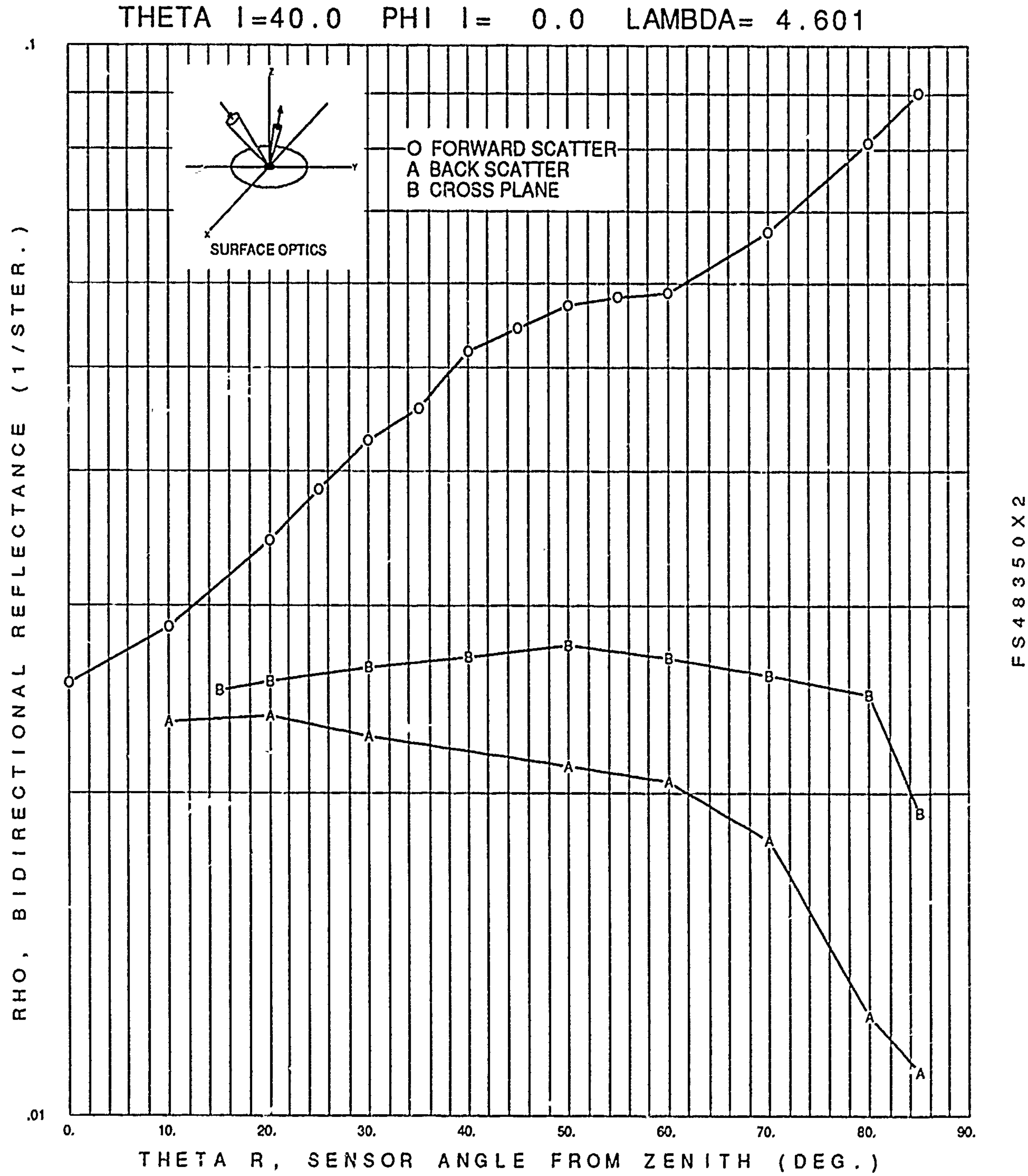

FIGURE C-15. SPECTRAL SCIENCES: LEAF SAMPLE, TOP SIDE
BIDIRECTIONAL REFLECTANCE VS. REFLECTED POLAR ANGLE
WAVELENGTH 4.601 MICROMETERS
INCIDENT POLAR ANGLE 40.0 DEGREES

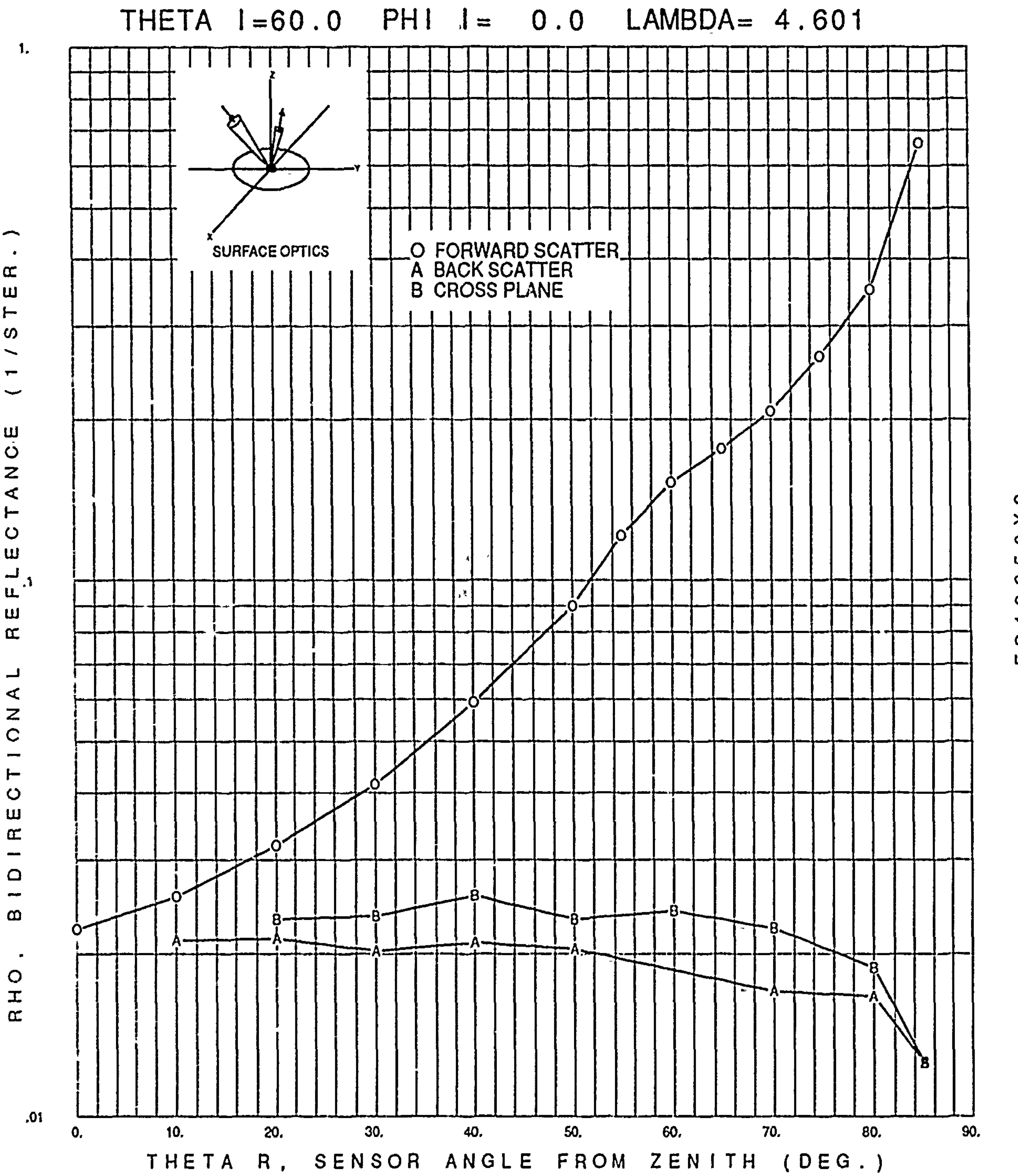

FIGURE C-16. SPECTRAL SCIENCES: LEAF SAMPLE, TOP SIDE
BIDIRECTIONAL REFLECTANCE VS. REFLECTED POLAR ANGLE
WAVELENGTH 4.601 MICROMETERS
INCIDENT POLAR ANGLE 60.0 DEGREES

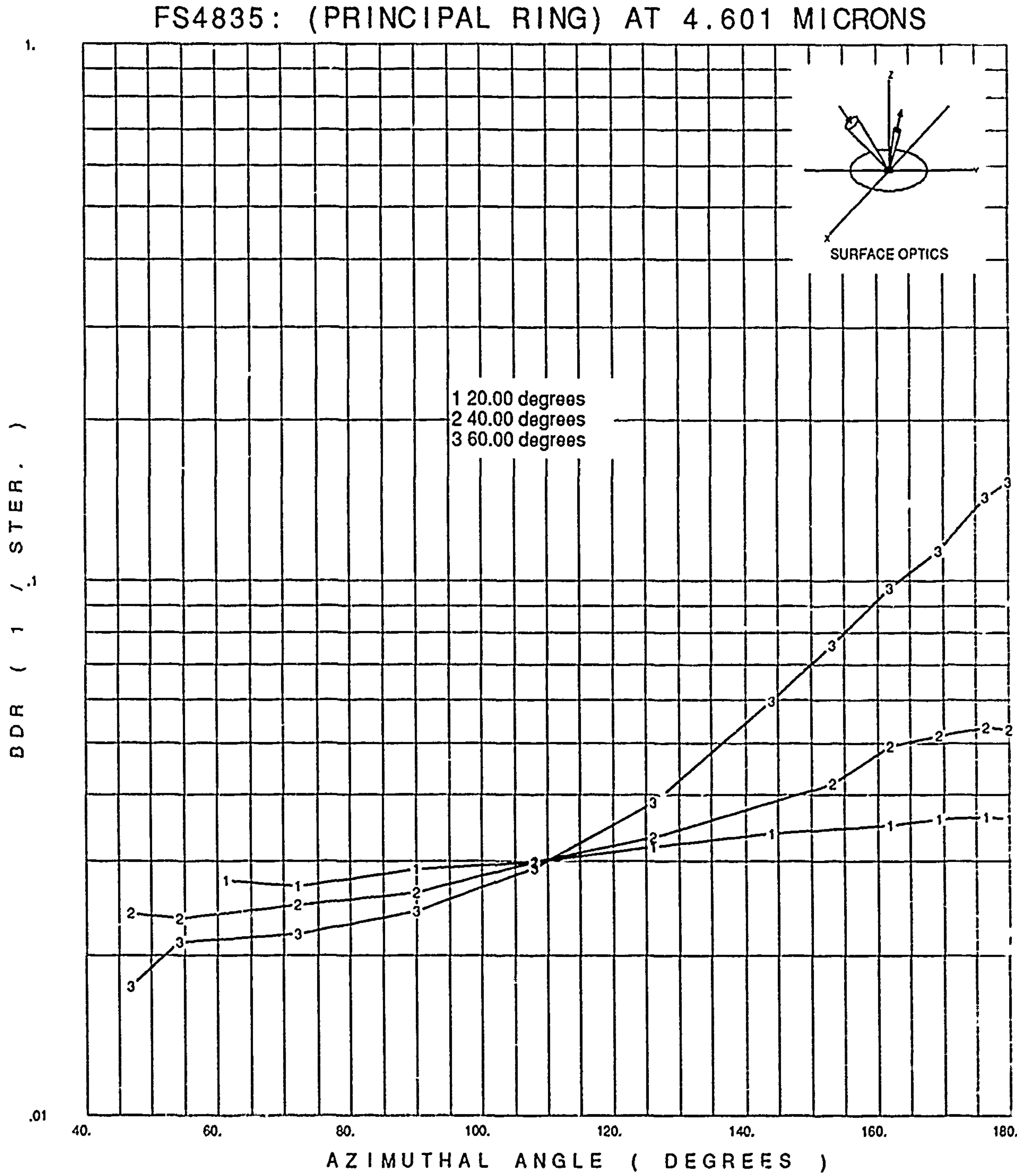

FIGURE C-17. SPECTRAL SCIENCES: LEAF SAMPLE, TOP SIDE
BIDIRECTIONAL REFLECTANCE VS. REFLECTED AZIMUTH ANGLE
PRINCIPAL RING AT 4.601 MICROMETERS
INCIDENT POLAR ANGLES 20, 40 AND 60 DEGREES

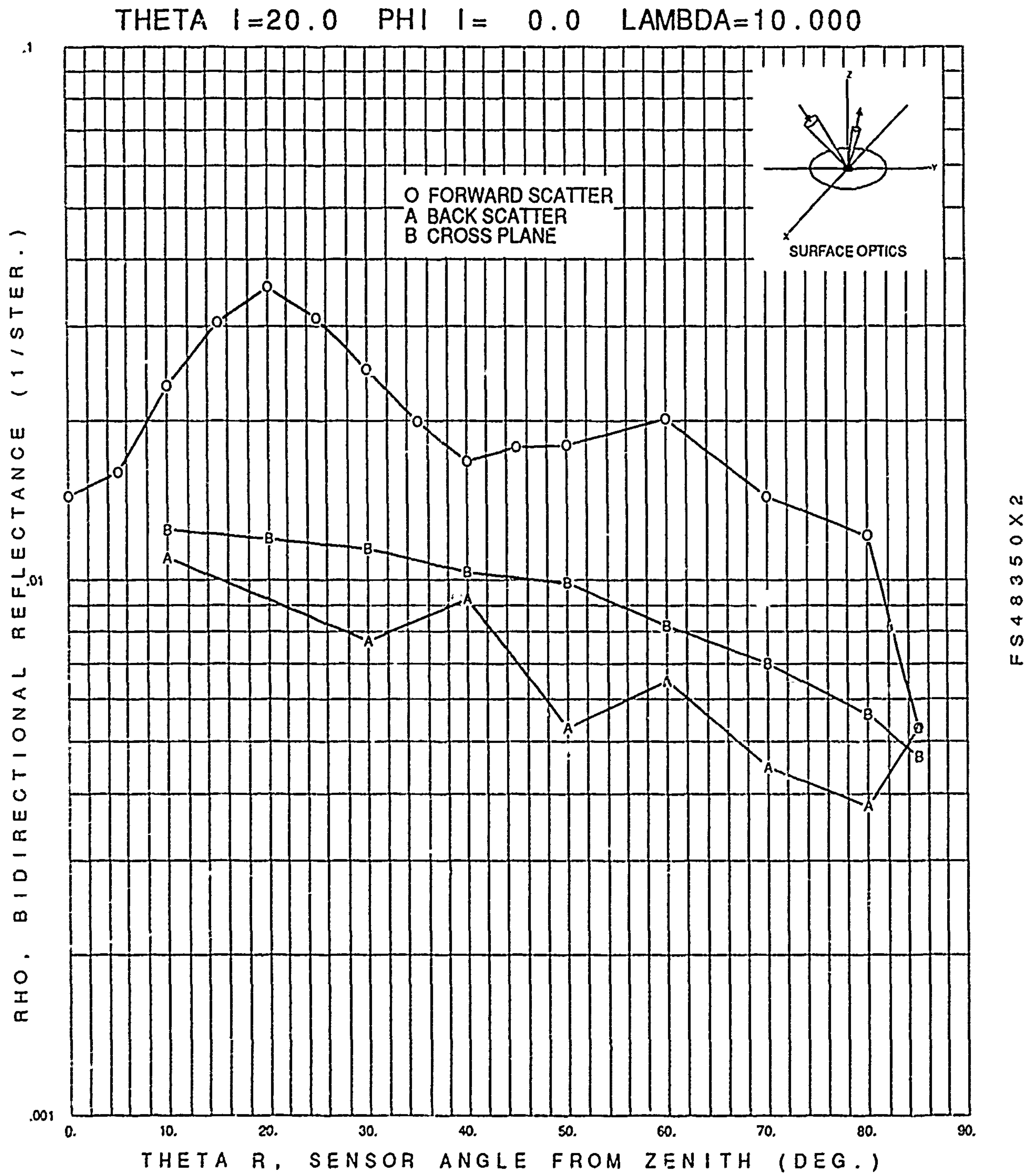

FIGURE C-18. SPECTRAL SCIENCES: LEAF SAMPLE, TOP SIDE
BIDIRECTIONAL REFLECTANCE VS. REFLECTED POLAR ANGLE
WAVELENGTH 10.000 MICROMETERS
INCIDENT POLAR ANGLE 20.0 DEGREES

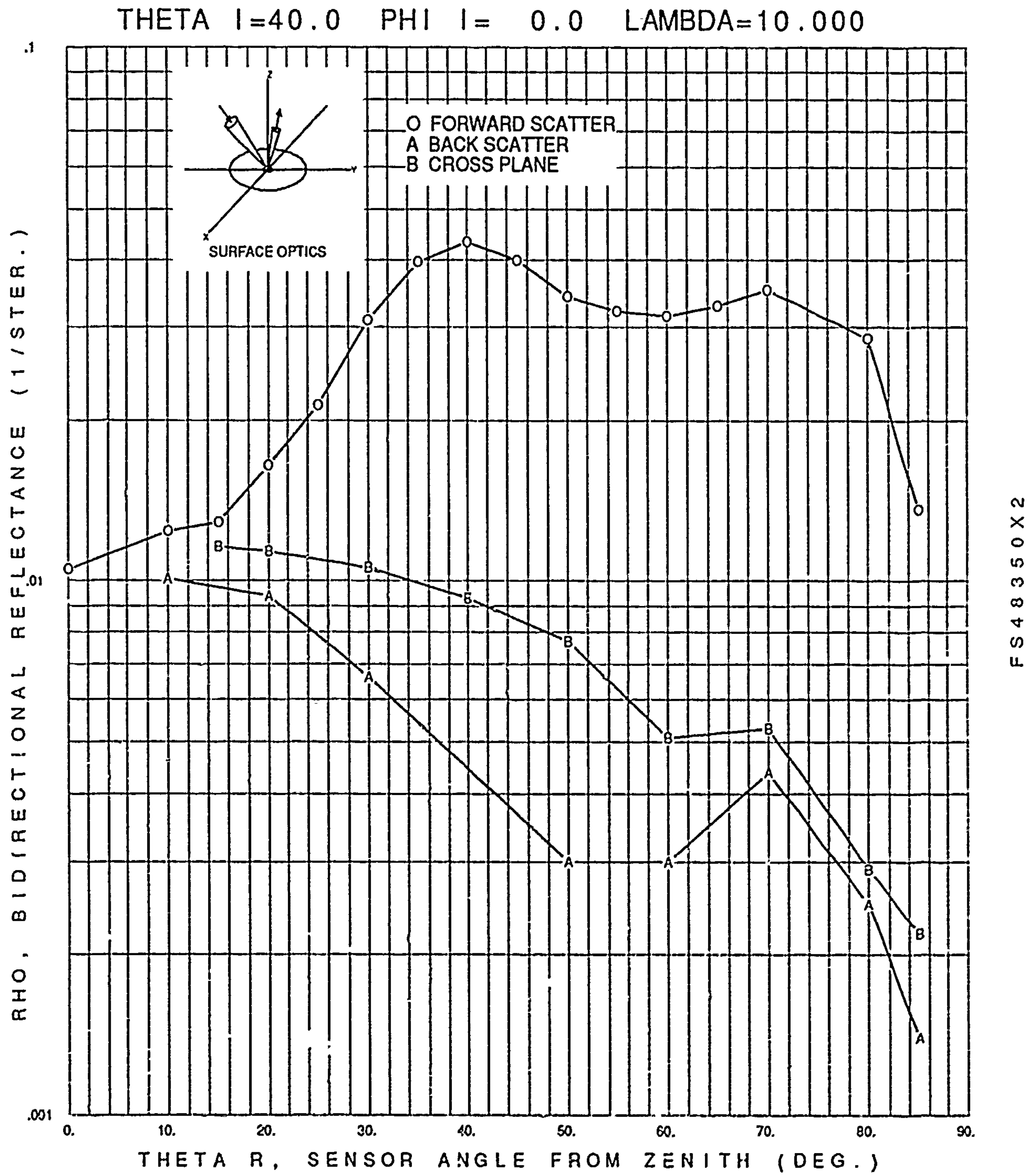

FIGURE C-19. SPECTRAL SCIENCES: LEAF SAMPLE, TOP SIDE
BIDIRECTIONAL REFLECTANCE VS. REFLECTED POLAR ANGLE
WAVELENGTH 10.000 MICROMETERS
INCIDENT POLAR ANGLE 40.0 DEGREES

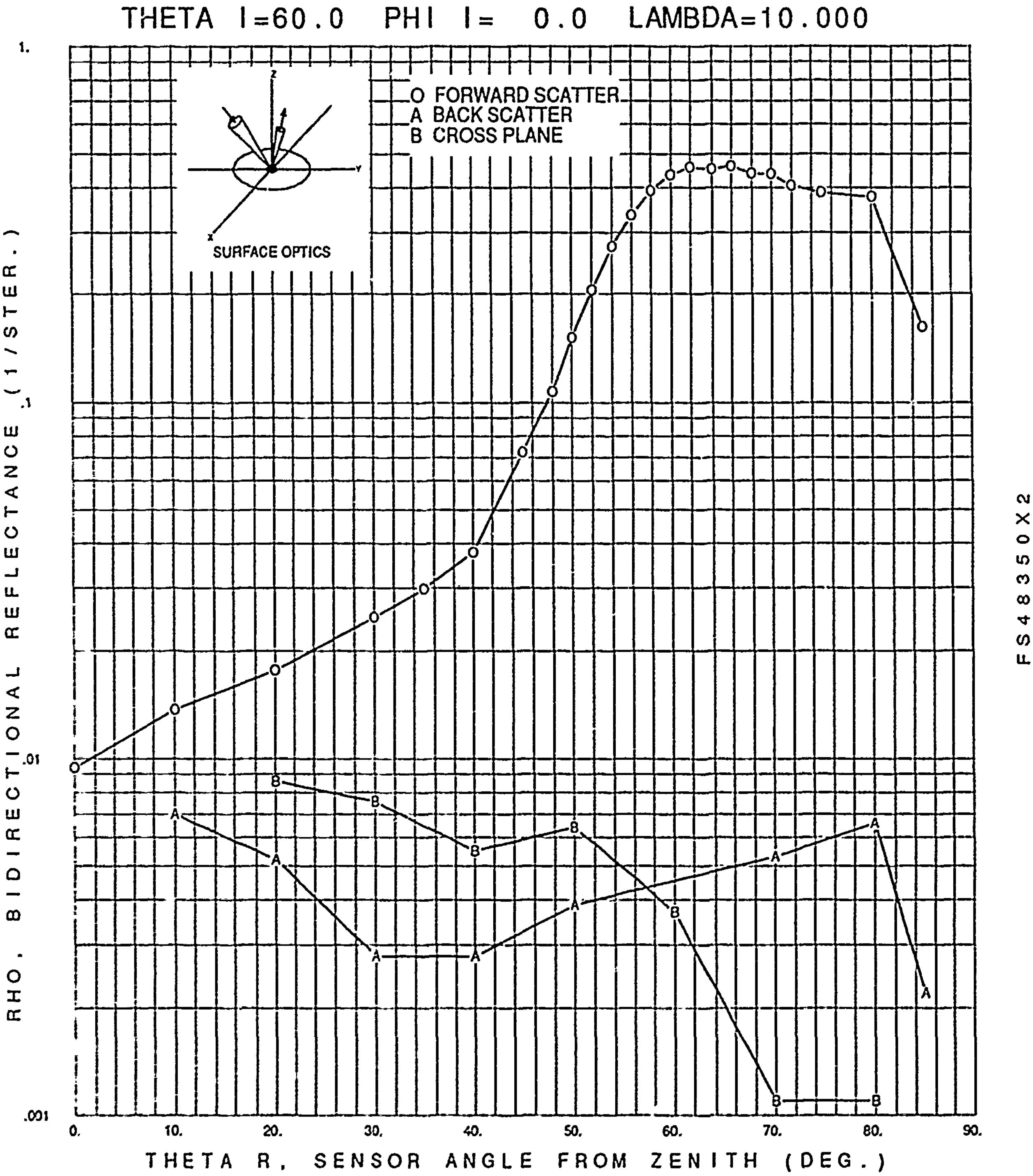

FIGURE C-20. SPECTRAL SCIENCES: LEAF SAMPLE, TOP SIDE
BIDIRECTIONAL REFLECTANCE VS. REFLECTED POLAR ANGLE
WAVELENGTH 10.000 MICROMETERS
INCIDENT POLAR ANGLE 60.0 DEGREES

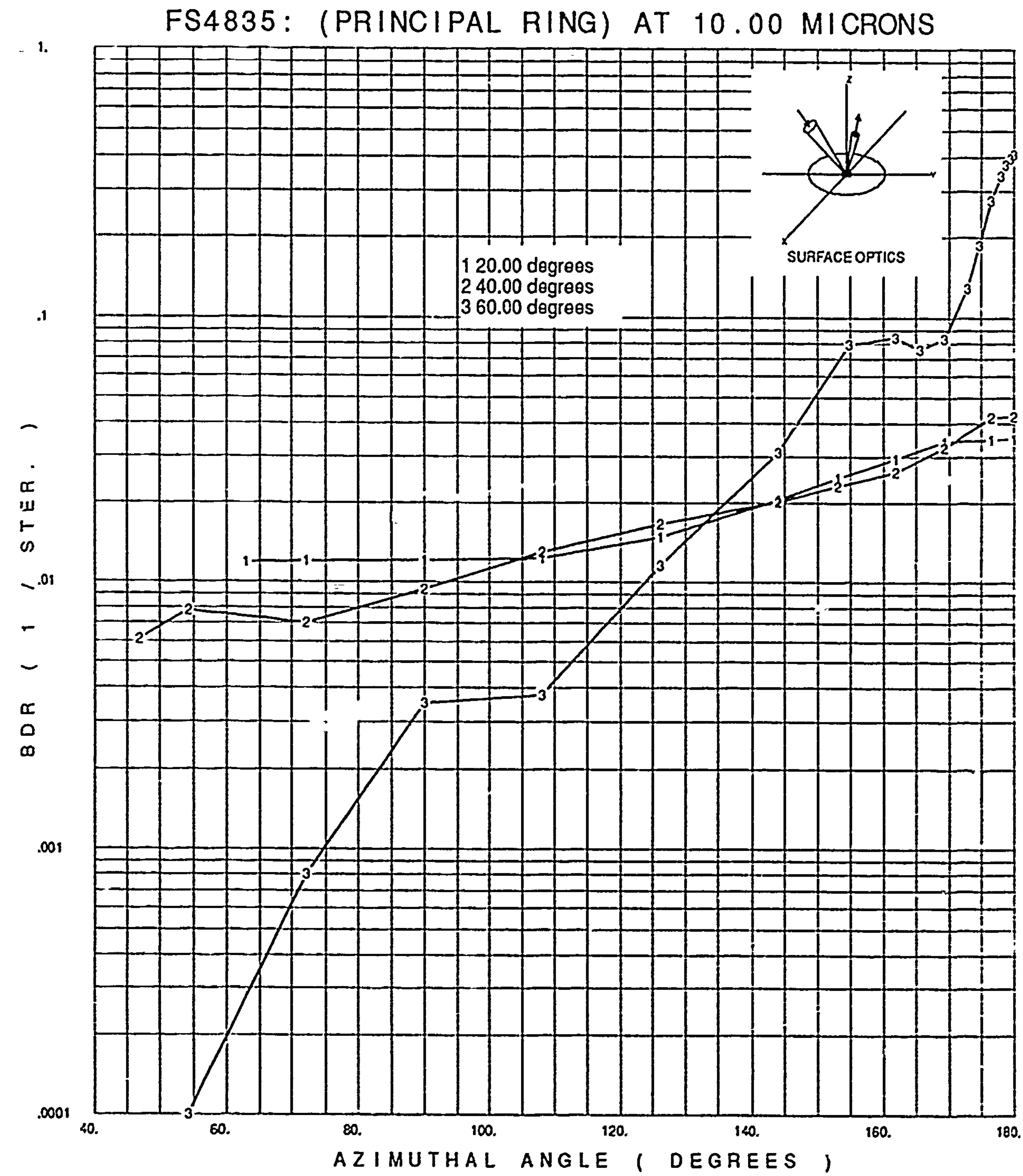

FIGURE C-21. SPECTRAL SCIENCES: LEAF SAMPLE, TOP SIDE
BIDIRECTIONAL REFLECTANCE VS. REFLECTED AZIMUTH ANGLE
PRINCIPAL RING AT 10.00 MICROMETERS
INCIDENT POLAR ANGLES 20, 40 AND 60 DEGREES

APPENDIX C

TABLE C-6. SPECTRAL SCIENCES: LEAF SAMPLE, TOP SIDE. PHI = 0
BIDIRECTIONAL REFLECTANCE VS. REFLECTED POLAR ANGLE
ERAS DATA
WAVELENGTH 1.307, 4.601, 10 MICROMETERS
INCIDENT POLAR ANGLES 20, 40, 60 DEGREES

FS48350X25001		36	013								
FS48350X25101		SPECTRAL SCIENCES: LEAF SAMPLE, TOP SIDE									
FS48350X27004						760.					
FS48350X29001	1		4 10	0.0	85.0	14	1.307	20.0	0.0		180.0
FS48350X29201	1	0.0	.0992	5.0	.0995	10.0	.1014	15.0	.1014	20.0	.1043
FS48350X29202	1	25.0	.1063	30.0	.1044	35.0	.1078	40.0	.1073	50.0	.1077
FS48350X29203	1	60.0	.1121	70.0	.115	80.0	.1234	85.0	.1162		
FS48350X29001	2		4 10	10.0	85.0	8	1.307	20.0	0.0		0.0
FS48350X29201	2	10.0	.0993	30.0	.1001	40.0	.1008	50.0	.0986	60.0	.0801
FS48350X29202	2	70.0	.0882	80.0	.0841	85.0	.0622				
FS48350X29001	3		4 10	10.0	85.0	9	1.307	20.0	0.0		90.0
FS48350X29201	3	10.0	.0995	20.0	.1025	30.0	.1042	40.0	.1048	50.0	.1077
FS48350X29202	3	60.0	.1112	70.0	.1095	80.0	.1221	85.0	.1324		
FS48350X29001	4		5 10	72.0	180.0	10	1.307	20.0	0.0	20.0	
FS48350X29201	4	72.0	.1005	90.0	.1013	108.0	.101	126.0	.1015	144.0	.1025
FS48350X29202	4	153.0	.1025	162.0	.1028	169.2	.1023	176.4	.1033	180.0	.1028
FS48350X29001	5		4 10	0.0	85.0	14	1.307	40.0	0.0		180.0
FS48350X29201	5	0.0	.0956	10.0	.0968	20.0	.1005	25.0	.103	30.0	.1064
FS48350X29202	5	35.0	.1086	40.0	.1131	45.0	.1197	50.0	.1232	55.0	.1254
FS48350X29203	5	60.0	.1294	70.0	.1402	80.0	.1714	85.0	.179		
FS48350X29001	6		4 10	10.0	85.0	8	1.307	40.0	0.0		0.0
FS48350X29201	6	10.0	.0954	20.0	.0969	30.0	.0984	50.0	.1002	60.0	.104
FS48350X29202	6	70.0	.1031	80.0	.0965	85.0	.053				
FS48350X29001	7		4 10	15.0	85.0	9	1.307	40.0	0.0		90.0
FS48350X29201	7	15.0	.0999	20.0	.1012	30.0	.1031	40.0	.1086	50.0	.1115
FS48350X29202	7	60.0	.1179	70.0	.12	80.0	.1231	85.0	.126		
FS48350X29001	8		5 10	54.0	180.0	10	1.307	40.0	0.0	40.0	
FS48350X29201	8	54.0	.106	72.0	.106	90.0	.1041	108.0	.106	126.0	.1071
FS48350X29202	8	144.0	.1086	162.0	.1101	169.2	.1128	176.4	.1139	180.0	.1154
FS48350X29001	9		4 10	0.0	85.0	14	1.307	60.0	0.0		180.0
FS48350X29201	9	0.0	.108	10.0	.1106	20.0	.1187	30.0	.1273	40.0	.1422
FS48350X29202	9	45.0	.1559	50.0	.1694	55.0	.1906	60.0	.2178	65.0	.2556
FS48350X29203	9	70.0	.3029	75.0	.354	80.0	.4487	85.0	.5892		
FS48350X29001	10		4 10	10.0	85.0	8	1.307	60.0	0.0		0.0
FS48350X29201	10	10.0	.1083	20.0	.1102	30.0	.1119	40.0	.1167	50.0	.1274
FS48350X29202	10	70.0	.1333	80.0	.1529	85.0	.0914				
FS48350X29001	11		4 10	20.0	85.0	8	1.307	60.0	0.0		90.0
FS48350X29201	11	20.0	.1126	30.0	.116	40.0	.1208	50.0	.1274	60.0	.1346
FS48350X29202	11	70.0	.1553	80.0	.1759	85.0	.1778				
FS48350X29001	12		5 10	54.0	180.0	11	1.307	60.0	0.0	60.0	
FS48350X29201	12	54.0	.1363	72.0	.1372	90.0	.1346	108.0	.1372	126.0	.1452
FS48350X29202	12	144.0	.1611	153.0	.17	162.0	.1903	169.2	.2027	176.4	.2178
FS48350X29203	12	180.0	.2134								
FS48350X29001	13		4 10	0.0	85.0	14	4.601	20.0	0.0		180.0
FS48350X29201	13	0.0	.0298	5.0	.0306	10.0	.0324	15.0	.0342	20.0	.0354
FS48350X29202	13	25.0	.0354	30.0	.0353	35.0	.0347	40.0	.0348	50.0	.0333
FS48350X29203	13	60.0	.0331	70.0	.033	80.0	.0314	85.0	.029		
FS48350X29001	14		4 10	10.0	85.0	8	4.601	20.0	0.0		0.0

APPENDIX C

TABLE C-6. (CONTINUED)

FS48350X29201	14	10.0	.0284	30.0	.0216	40.0	.0213	50.0	.0233	60.0	.0218
FS48350X29202	14	70.0	.0193	80.0	.0146	85.0	.0089				
FS48350X29001	15		4 10	10.0	85.0	9	4.601	20.0	0.0		90.0
FS48350X29201	15	10.0	.0274	20.0	.0281	30.0	.0272	40.0	.0264	50.0	.026
FS48350X29202	15	60.0	.0261	70.0	.0239	80.0	.0224	85.0	.0223		
FS48350X29001	16		5 10	61.2	180.0	10	4.601	20.0	0.0	20.0	
FS48350X29201	16	61.2	.0277	72.0	.0269	90.0	.029	108.0	.0298	126.0	.0319
FS48350X29202	16	144.0	.0339	162.0	.035	169.2	.036	176.4	.0362	180.0	.036
FS48350X29001	17		4 10	0.0	85.0	14	4.601	40.0	0.0		180.0
FS48350X29201	17	0.0	.0253	10.0	.0286	20.0	.0345	25.0	.0384	30.0	.0427
FS48350X29202	17	35.0	.0457	40.0	.0517	45.0	.0543	50.0	.0571	55.0	.0582
FS48350X29203	17	60.0	.0587	70.0	.067	80.0	.081	85.0	.0903		
FS48350X29001	18		4 10	10.0	85.0	8	4.601	40.0	0.0		0.0
FS48350X29201	18	10.0	.0233	20.0	.0236	30.0	.0226	50.0	.0212	60.0	.0205
FS48350X29202	18	70.0	.0181	80.0	.0124	85.0	.011				
FS48350X29001	19		4 10	15.0	85.0	9	4.601	40.0	0.0		90.0
FS48350X29201	19	15.0	.0249	20.0	.0254	30.0	.0262	40.0	.0268	50.0	.0275
FS48350X29202	19	60.0	.0267	70.0	.0258	80.0	.0247	85.0	.0192		
FS48350X29001	20		5 10	46.8	180.0	11	4.601	40.0	0.0	40.0	
FS48350X29201	20	46.8	.024	54.0	.0234	72.0	.0249	90.0	.0262	108.0	.0299
FS48350X29202	20	126.0	.0333	153.0	.0417	162.0	.0492	169.2	.0514	176.4	.0532
FS48350X29203	20	180.0	.0529								
FS48350X29001	21		4 10	0.0	85.0	13	4.601	60.0	0.0		180.0
FS48350X29201	21	0.0	.0223	10.0	.0256	20.0	.0319	30.0	.0414	40.0	.0592
FS48350X29202	21	50.0	.0898	55.0	.121	60.0	.1527	65.0	.1764	70.0	.2083
FS48350X29203	21	75.0	.2626	80.0	.3514	85.0	.6583				
FS48350X29001	22		4 10	10.0	85.0	8	4.601	60.0	0.0		0.0
FS48350X29201	22	10.0	.0212	20.0	.0214	30.0	.0203	40.0	.021	50.0	.0205
FS48350X29202	22	70.0	.0171	80.0	.0168	85.0	.0126				
FS48350X29001	23		4 10	20.0	85.0	8	4.601	60.0	0.0		90.0
FS48350X29201	23	20.0	.0233	30.0	.0236	40.0	.0258	50.0	.0233	60.0	.0241
FS48350X29202	23	70.0	.0224	80.0	.0189	85.0	.0126				
FS48350X29001	24		5 10	46.8	180.0	12	4.601	60.0	0.0	60.0	
FS48350X29201	24	46.8	.0175	54.0	.0212	72.0	.0219	90.0	.0241	108.0	.0292
FS48350X29202	24	126.0	.0387	144.0	.0599	153.0	.076	162.0	.0965	169.2	.1133
FS48350X29203	24	176.4	.1432	180.0	.1527						
FS48350X29001	25		4 10	0.0	85.0	15	10.000	20.0	0.0		180.0
FS48350X29201	25	0.0	.0144	5.0	.016	10.0	.0232	15.0	.0305	20.0	.0357
FS48350X29202	25	25.0	.031	30.0	.0249	35.0	.0199	40.0	.0168	45.0	.0179
FS48350X29203	25	50.0	.018	60.0	.0202	70.0	.0144	80.0	.0121	85.0	.0053
FS48350X29001	26		4 10	10.0	85.0	8	10.000	20.0	0.0		0.0
FS48350X29201	26	10.0	.011	30.0	.0077	40.0	.0092	50.0	.0053	60.0	.0065
FS48350X29202	26	70.0	.0045	80.0	.0038	85.0	.0053				
FS48350X29001	27		4 10	10.0	85.0	9	10.000	20.0	0.0		90.0
FS48350X29201	27	10.0	.0125	20.0	.012	30.0	.0115	40.0	.0104	50.0	.0099
FS48350X29202	27	60.0	.0082	70.0	.007	80.0	.0056	85.0	.0047		
FS48350X29001	28		5 10	63.0	180.0	11	10.000	20.0	0.0	20.0	
FS48350X29201	28	63.0	.0118	72.0	.0119	90.0	.012	108.0	.0123	126.0	.0147

TABLE C-6. (CONTINUED)

FS48350X29202	28	144.0	.0205	153.0	.0249	162.0	.0295	169.2	.0339	176.4	.0346
FS48350X29203	28	180.0	.035								
FS48350X29001	29		4 10	0.0	85.0	16	10.000	40.0	0.0		180.0
FS48350X29201	29	0.0	.0105	10.0	.0124	15.0	.0129	20.0	.0165	25.0	.0214
FS48350X29202	29	30.0	.0309	35.0	.0396	40.0	.0433	45.0	.04	50.0	.0341
FS48350X29203	29	55.0	.0322	60.0	.0314	65.0	.0328	70.0	.0352	80.0	.0286
FS48350X29204	29	85.0	.0137								
FS48350X29001	30		4 10	10.0	85.0	8	10.000	40.0	0.0		0.0
FS48350X29201	30	10.0	.0101	20.0	.0094	30.0	.0066	50.0	.003	60.0	.003
FS48350X29202	30	70.0	.0044	80.0	.0025	85.0	.0014				
FS48350X29001	31		4 10	15.0	85.0	9	10.000	40.0	0.0		90.0
FS48350X29201	31	15.0	.0116	20.0	.0114	30.0	.0106	40.0	.0093	50.0	.0077
FS48350X29202	31	60.0	.0051	70.0	.0053	80.0	.0029	85.0	.0022		
FS48350X29001	32		5 10	46.8	180.0	12	10.000	40.0	0.0	40.0	
FS48350X29201	32	46.8	.0061	54.0	.0078	72.0	.007	90.0	.0093	108.0	.0129
FS48350X29202	32	126.0	.0165	144.0	.0202	153.0	.023	162.0	.0261	169.2	.0323
FS48350X29203	32	176.4	.0419	180.0	.0425						
FS48350X29001	33		4 10	0.0	85.0	23	10.000	60.0	0.0		180.0
FS48350X29201	33	0.0	.0094	10.0	.0137	20.0	.0176	30.0	.0249	35.0	.0298
FS48350X29202	33	40.0	.0379	45.0	.0718	48.0	.1069	50.0	.1514	52.0	.2065
FS48350X29203	33	54.0	.2728	56.0	.3349	58.0	.3941	60.0	.4354	62.0	.4563
FS48350X29204	33	64.0	.4509	66.0	.4619	68.0	.4415	70.0	.4369	72.0	.4064
FS48350X29205	33	75.0	.3863	80.0	.3776	85.0	.1611				
FS48350X29001	34		4 10	10.0	85.0	8	10.000	60.0	0.0		0.0
FS48350X29201	34	10.0	.007	20.0	.0052	30.0	.0028	40.0	.0028	50.0	.0039
FS48350X29202	34	70.0	.0053	80.0	.0066	85.0	.0022				
FS48350X29001	35		4 10	20.0	80.0	7	10.000	60.0	0.0		90.0
FS48350X29201	35	20.0	.0086	30.0	.0076	40.0	.0055	50.0	.0064	60.0	.0037
FS48350X29202	35	70.0	.0011	80.0	.0011						
FS48350X29001	36		5 10	54.0	180.0	17	10.000	60.0	0.0	60.0	
FS48350X29201	36	54.0	0.	72.0	.0008	90.0	.0035	108.0	.0038	126.0	.0115
FS48350X29202	36	144.0	.0308	154.8	.0792	162.0	.0835	165.6	.0754	169.2	.0831
FS48350X29203	36	172.8	.1285	174.6	.1854	176.4	.2727	177.8	.3384	178.6	.3738
FS48350X29204	36	179.3	.3965	180.0	.4077						

TRANSMITTANCE VERSUS WAVELENGTH

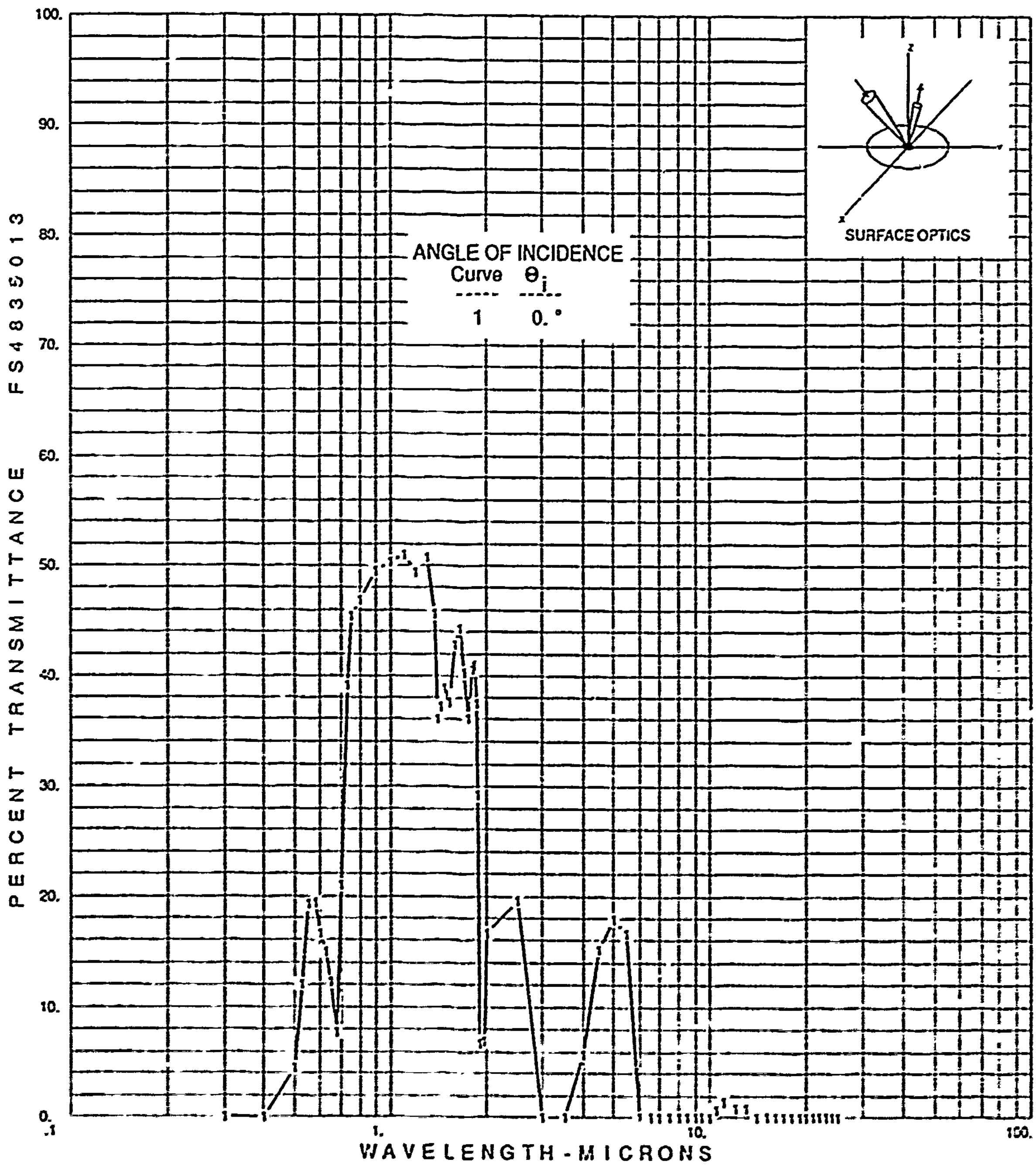

FIGURE C-22. SPECTRAL SCIENCES: LEAF SAMPLE, TOP SIDE SCATTERED TRANSMITTANCE VS. WAVELENGTH BANDWIDTH 0.3 TO 25.0 MICROMETERS

APPENDIX C

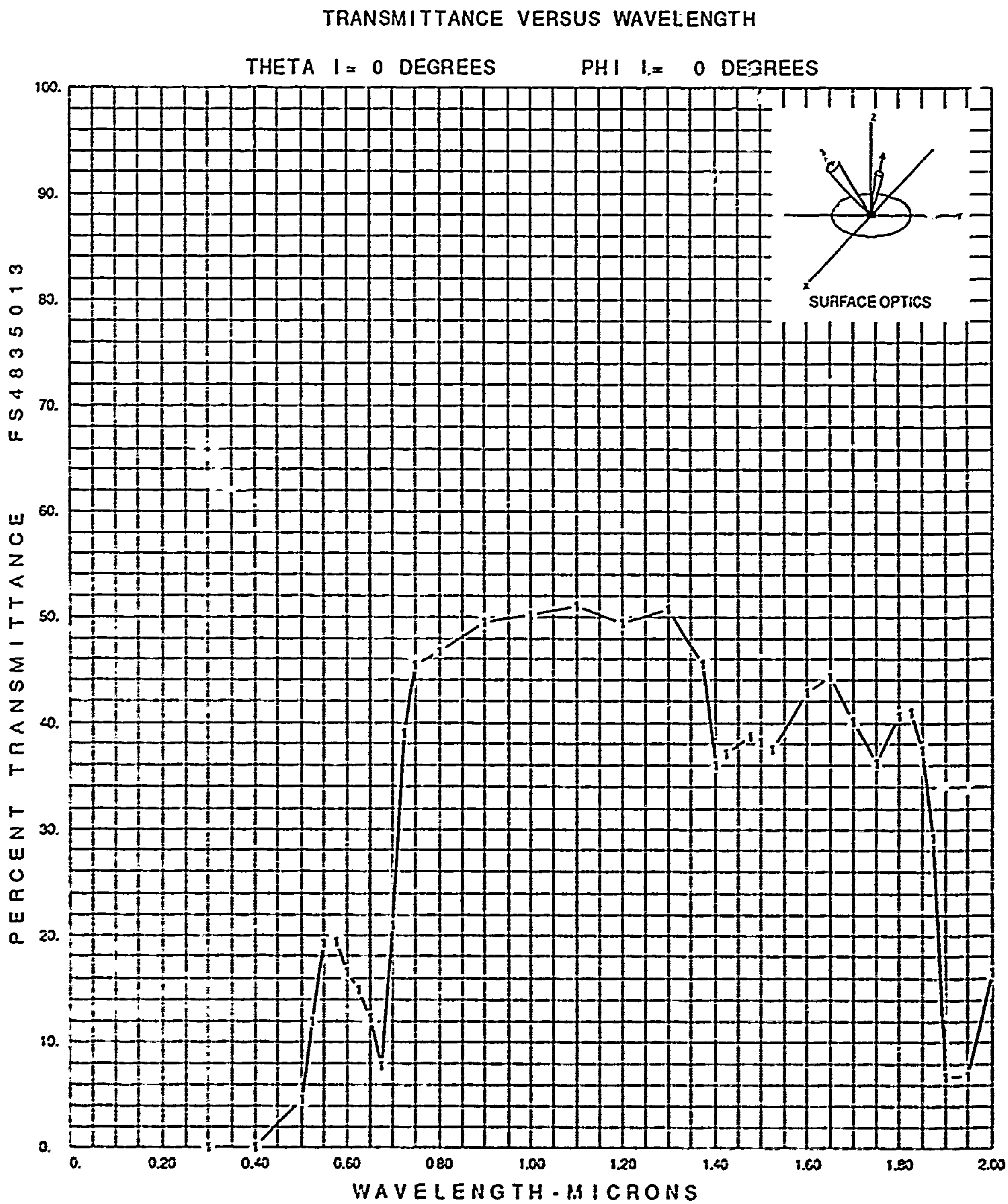

FIGURE C-23. SPECTRAL SCIENCES: LEAF SAMPLE, TOP SIDE SCATTERED TRANSMITTANCE VS. WAVELENGTH BANDWIDTH 0.3 TO 2.0 MICROMETERS

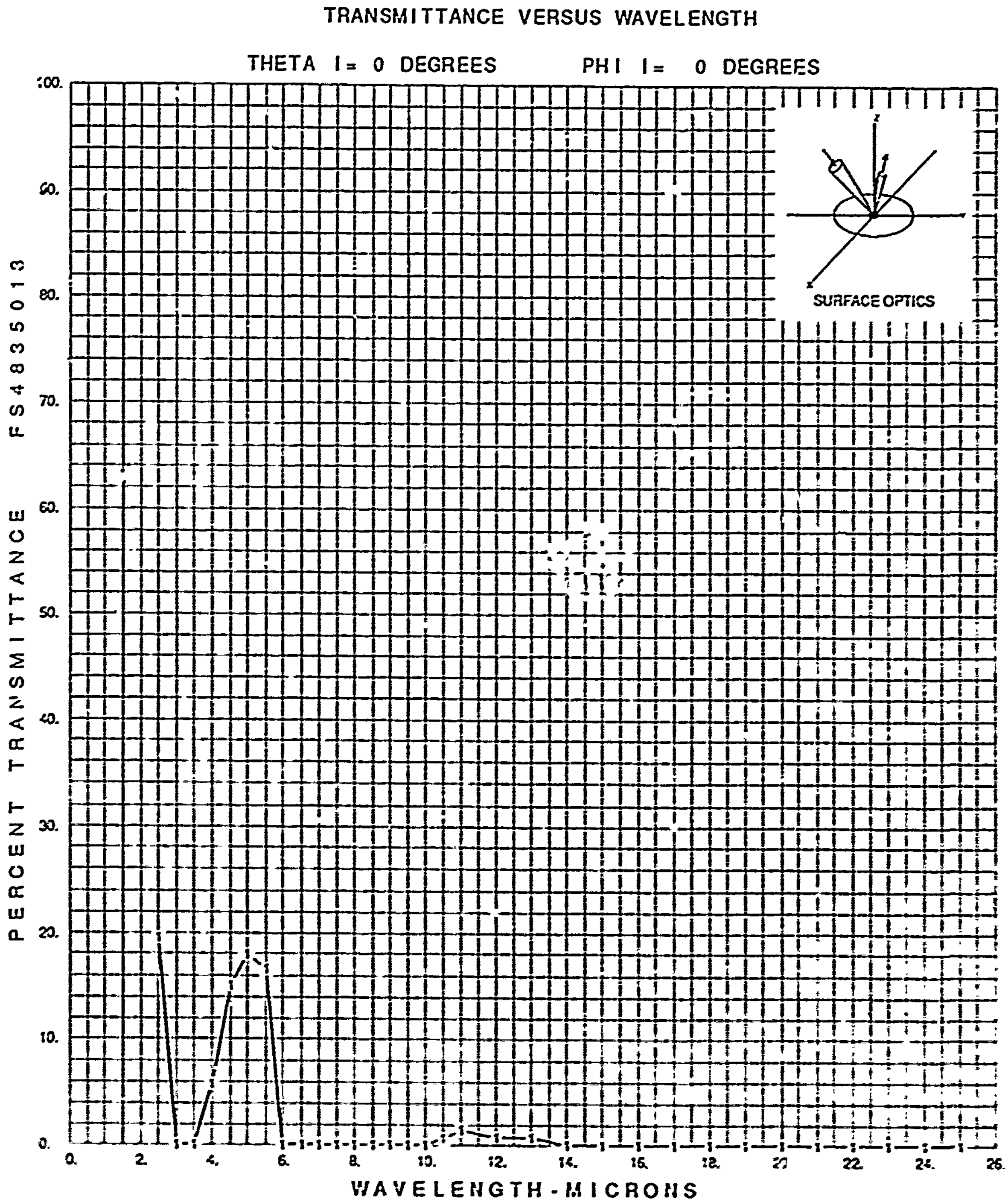

FIGURE C-24. SPECTRAL SCIENCES: LEAF SAMPLE, TOP SIDE SCATTERED TRANSMITTANCE VS. WAVELENGTH BANDWIDTH 2.5 TO 25.0 MICROMETERS

APPENDIX C

TABLE C-7. SPECTRAL SCIENCES: LEAF SAMPLE, TOP SIDE
SCATTERED TRANSMITTANCE VS. WAVELENGTH - ERAS DATA
DATA FROM 0.3 TO 2.0 MICROMETERS MEASURED
ON A FRESH, MOIST LEAF

FS48350135001		1	31								
FS48350135101		SPECTRAL SCIENCES: LEAF SAMPLE, TOP SIDE									
FS48350135102		SCATTERED TRANSMITTANCE									
FS48350137001		092790									
FS48350139001	1	001	31	.3	25.	68				0.	0.
FS48350139201	1	.3	0.0	.4	0.0	.5	4.5	.525	12.0	.55	19.2
FS48350139202	1	.575	19.3	.6	16.6	.625	14.9	.65	12.2	.675	7.7
FS48350139203	1	.7	21.0	.725	39.1	.75	45.4	.8	46.8	.9	49.5
FS48350139204	1	1.	50.3	1.1	51.0	1.2	49.4	1.3	50.7	1.375	45.6
FS48350139205	1	1.4	36.0	1.425	37.1	1.475	38.8	1.5	38.2	1.525	37.5
FS48350139206	1	1.6	42.8	1.65	44.3	1.7	40.2	1.75	36.2	1.8	40.6
FS48350139207	1	1.825	41.0	1.85	37.4	1.875	29.2	1.9	6.7	1.95	6.9
FS48350139208	1	2.	16.6	2.5	19.6	3.	0.0	3.5	0.0	4.	5.8
FS48350139209	1	4.5	15.1	5.	17.9	5.5	16.6	6.	0.0	6.5	0.0
FS48350139210	1	7.	0.0	7.5	0.0	8.	0.0	8.5	0.0	9.	0.0
FS48350139211	1	9.5	0.0	10.	0.0	10.5	0.7	11.	1.5	12.	0.8
FS48350139212	1	13.	0.8	14.	0.0	15.	0.0	16.	0.0	17.	0.0
FS48350139213	1	18.	0.0	19.	0.0	20.	0.0	21.	0.0	22.	0.0
FS48350139214	1	23.	0.0	24.	0.0	25.	0.0				

APPENDIX D

SPECTRAL SCIENCES INC.
LEAF SAMPLE, BOTTOM SIDE
FS4836:

INDEX TO APPENDIX D

PAGE NO.

DIRECTIONAL REFLECTANCE

INDEX TO APPENDIX D (continued)

PAGE NO.

DIRECTIONAL REFLECTANCE

BIDIRECTIONAL REFLECTANCE

APPENDIX D

INDEX TO APPENDIX D (continued)

PAGE NO.

BIDIRECTIONAL REFLECTANCE

INDEX TO APPENDIX D (continued)

PAGE NO.

BIDIRECTIONAL REFLECTANCE

SCATTERED TRANSMITTANCE

APPENDIX D

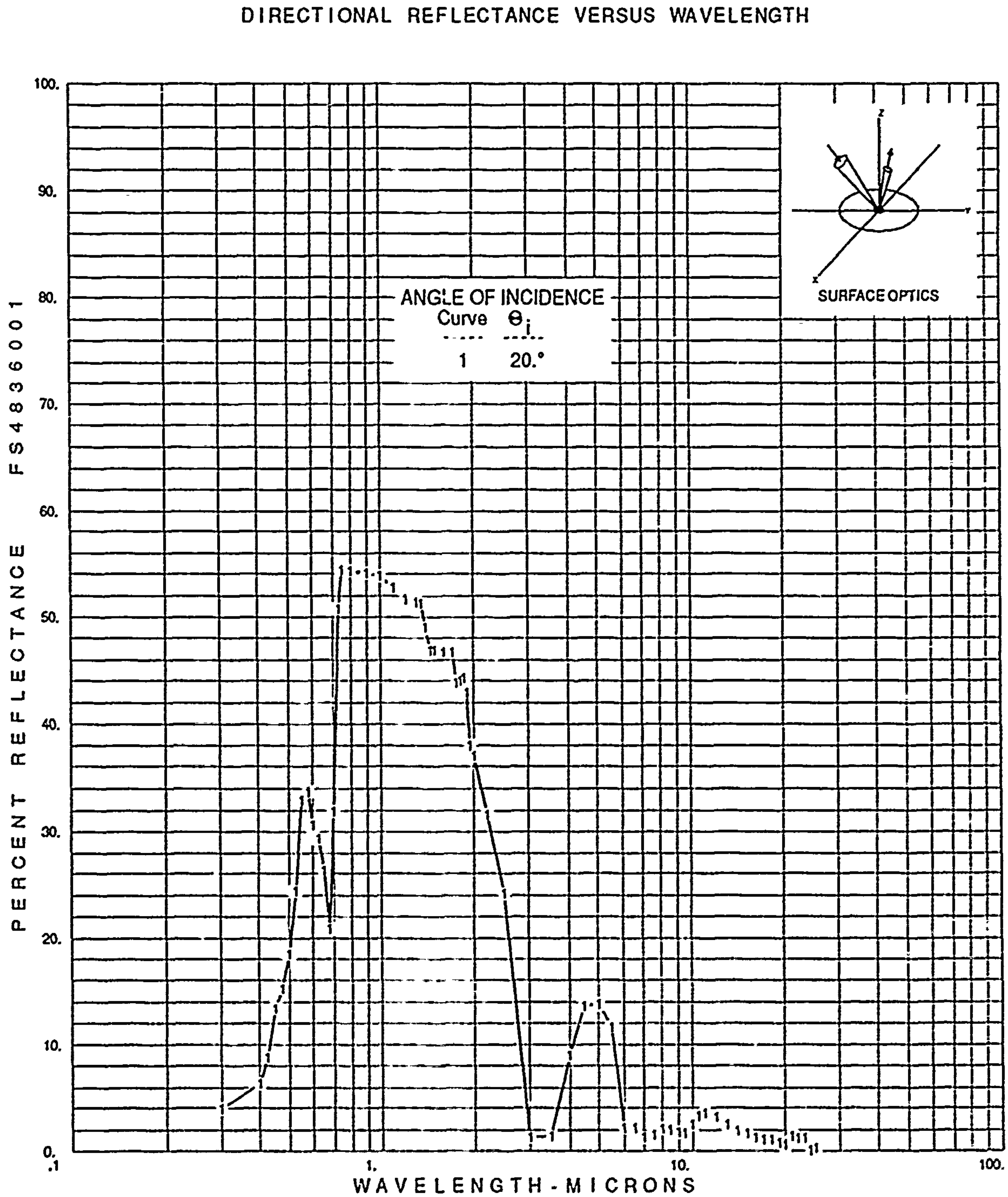

FIGURE D-1. SPECTRAL SCIENCES: LEAF SAMPLE, BOTTOM SIDE
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 25.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX D

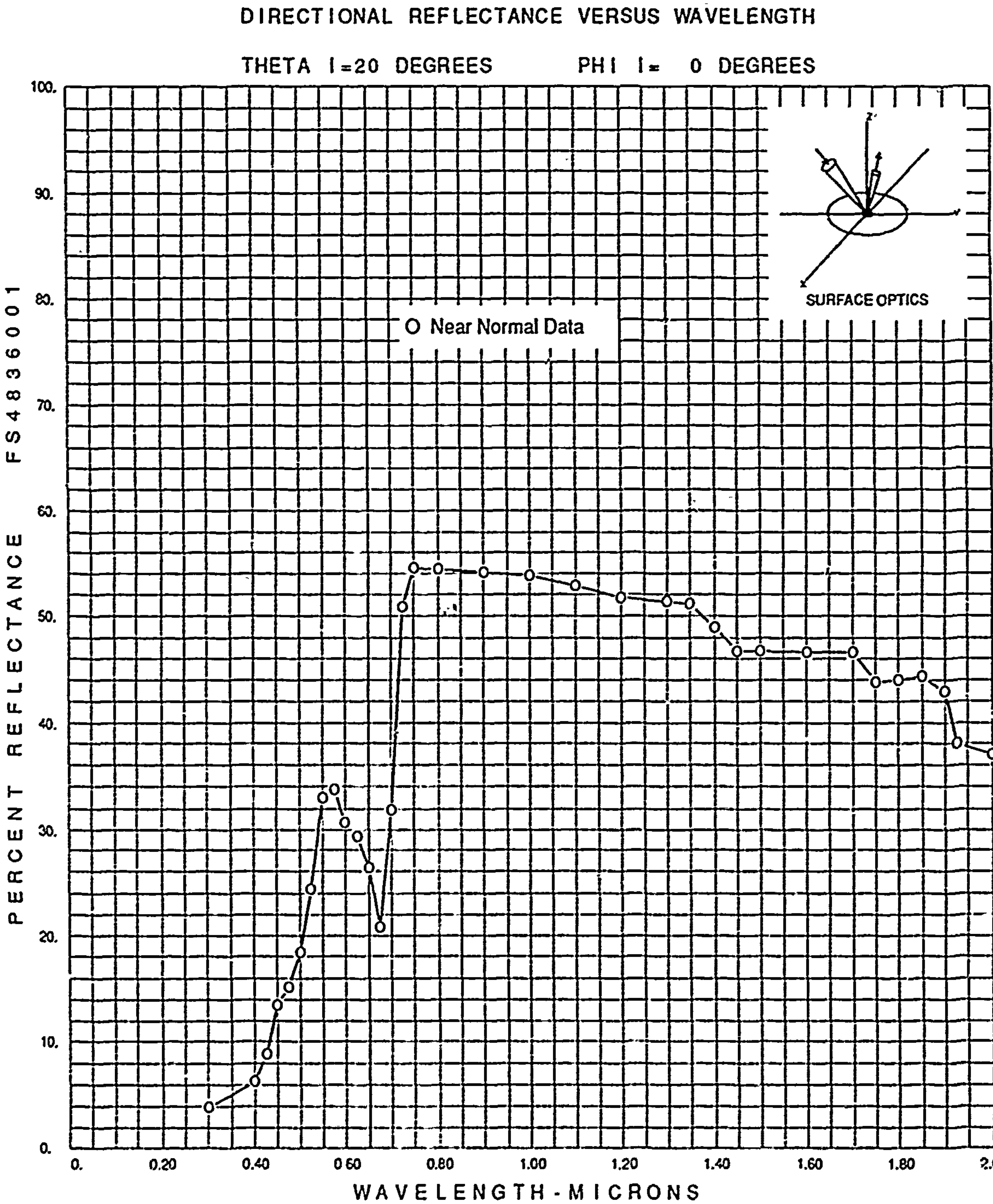

FIGURE D-2. SPECTRAL SCIENCES: LEAF SAMPLE, BOTTOM SIDE
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 2.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX D

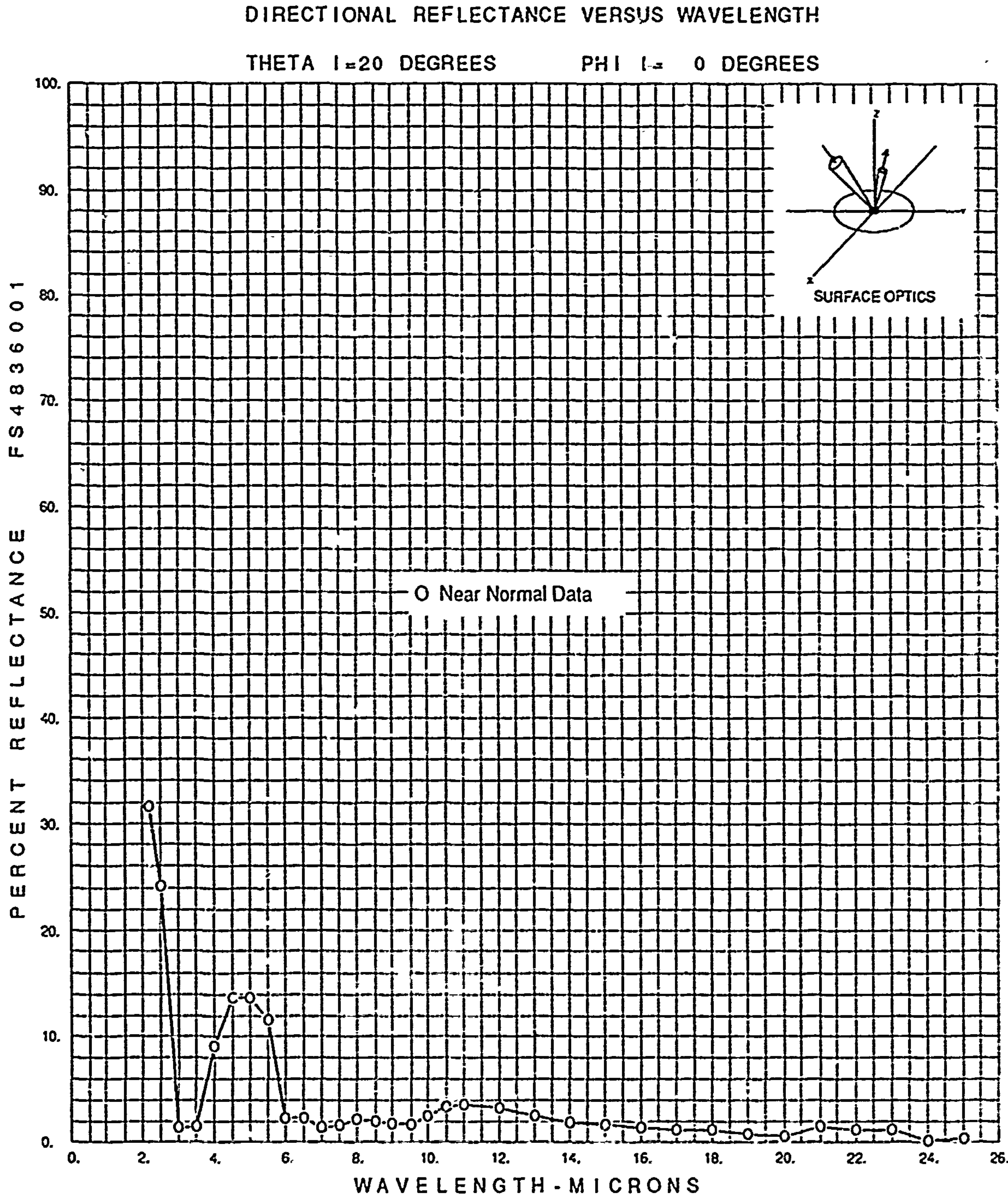

FIGURE D-3. SPECTRAL SCIENCES: LEAF SAMPLE, BOTTOM SIDE
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 2.2 TO 25.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX D

TABLE D-1. SPECTRAL SCIENCES: LEAF SAMPLE, BOTTOM SIDE. PHI = 0
DIRECTIONAL REFLECTANCE VS. WAVELENGTH - ERAS DATA
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

```
FS48360015001         1       1
FS48360015101     SPECTRAL SCIENCES: LEAF SAMPLE, BOTTOM SIDE
FS48360015102     UNCORRECTED FOR INSTRUMENTATION POLARIZATION EFFECTS
FS48360017001     101090
FS48360019001  1       001  1     .3   25.  67                      20.     0.
FS48360019201  1     .3   3.9    .4   6.3  .425   8.8   .45  13.4  .475  15.2
FS48360019202  1     .5  18.5  .525  24.4   .55  32.9  .575  33.7    .6  30.6
FS48360019203  1   .625  29.3   .65  26.4  .675  20.8    .7  31.8  .725  50.8
FS48360019204  1    .75  54.5    .8  54.4    .9  54.1    1.  53.8   1.1  52.8
FS48360019205  1    1.2  51.7   1.3  51.4  1.35  51.2   1.4  49.0  1.45  46.8
FS48360019206  1    1.5  46.8   1.6  46.7   1.7  46.7  1.75  43.8   1.8  44.0
FS48360019207  1   1.85  44.3   1.9  42.9 1.925  38.0    2.  37.0   2.2  31.5
FS48360019208  1    2.5  24.2    3.   1.4   3.5   1.5    4.   9.0   4.5  13.6
FS48360019209  1     5.  13.7   5.5  11.6    6.   2.2   6.5   2.2    7.   1.4
FS48360019210  1    7.5   1.6    8.   2.1   8.5   2.0    9.   1.8   9.5   1.7
FS48360019211  1    10.   2.5  10.5   3.3   11.   3.6   12.   3.2   13.   2.5
FS48360019212  1    14.   1.9   15.   1.7   16.   1.4   17.   1.1   18.   1.1
FS48360019213  1    19.   0.8   20.   0.6   21.   1.5   22.   1.2   23.   1.2
FS48360019214  1    24.   0.2   25.   0.4
```

APPENDIX D

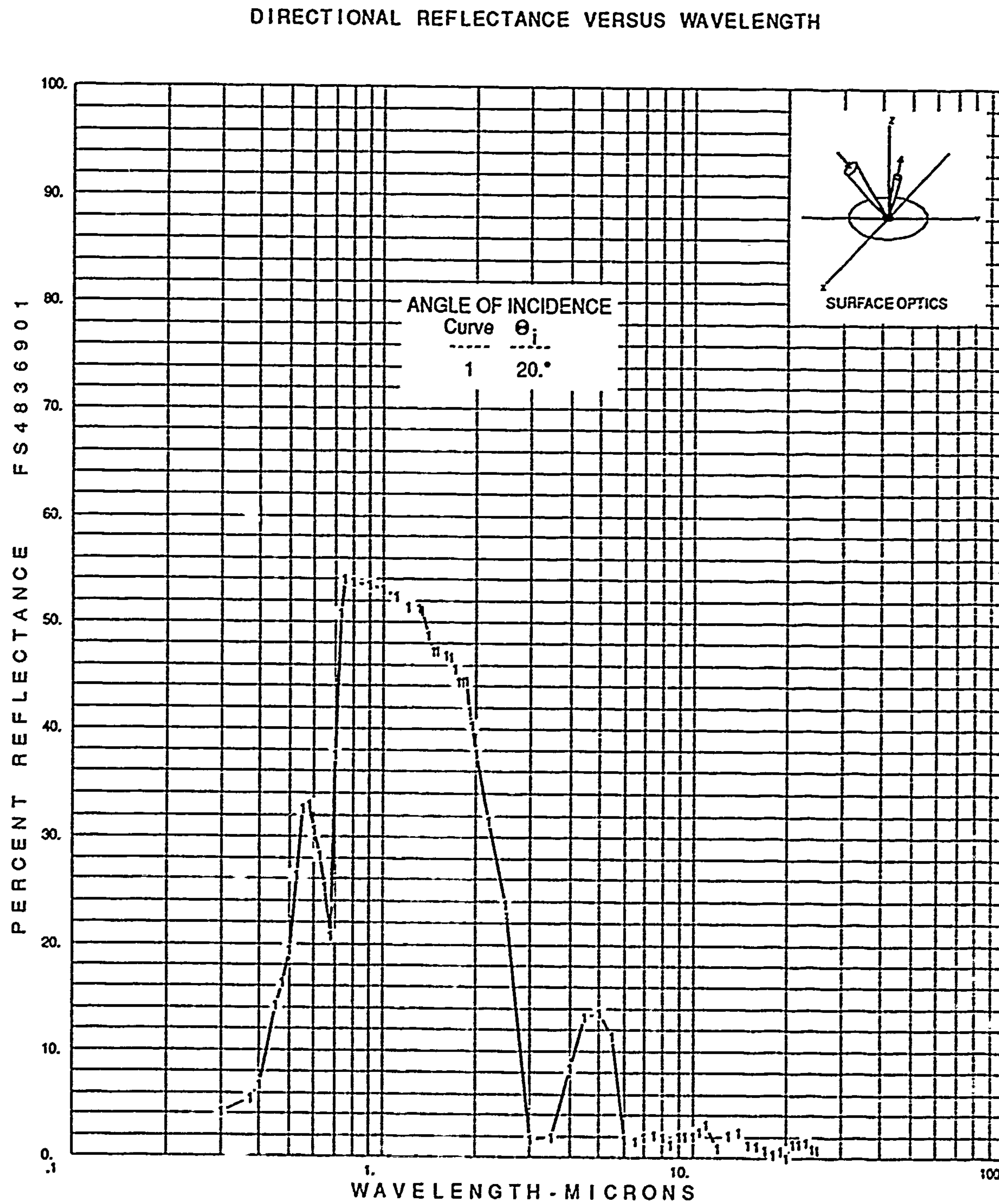

FIGURE D-4. SPECTRAL SCIENCES: LEAF SAMPLE, BOTTOM SIDE. PHI=90
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 25.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX D

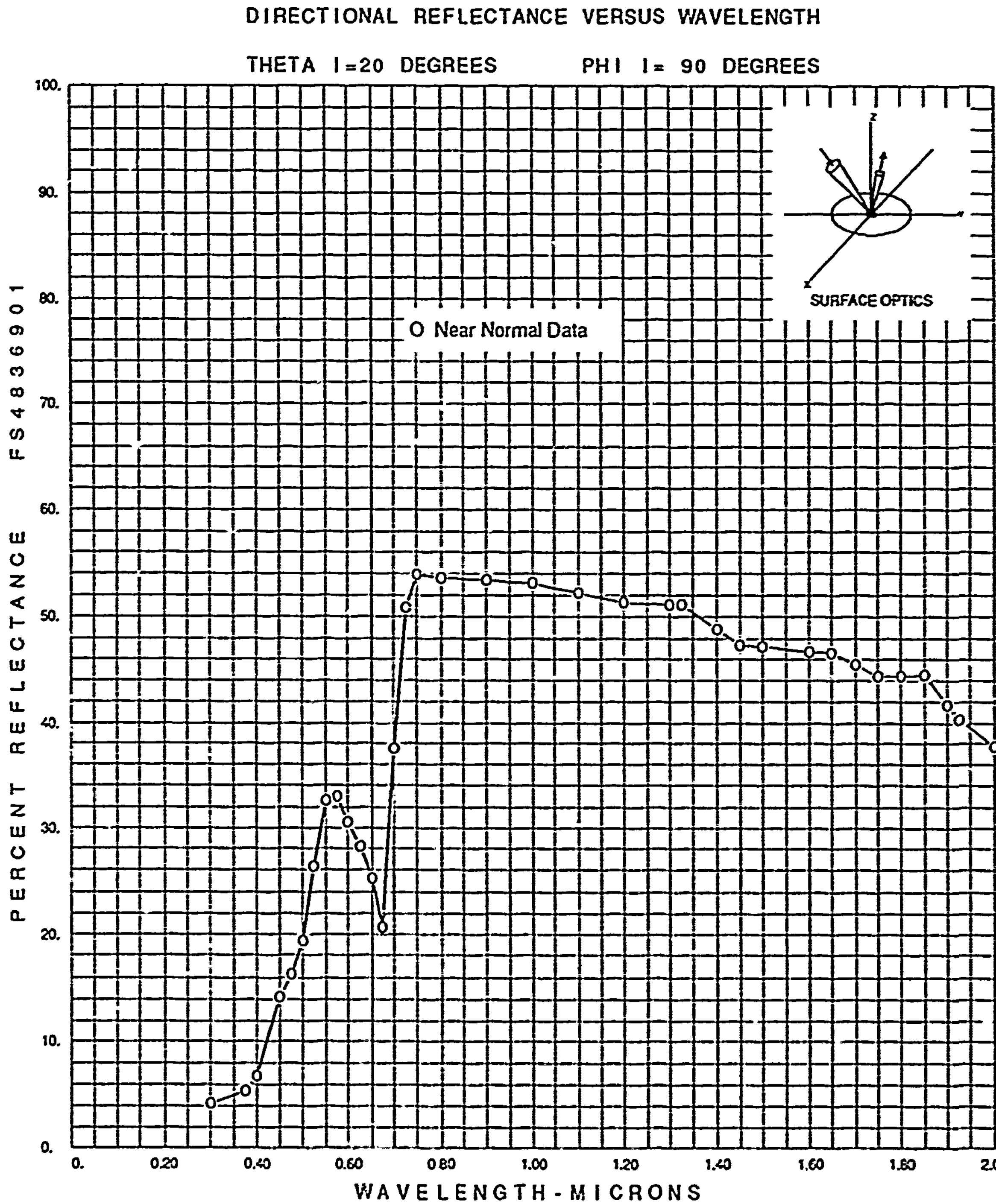

FIGURE D-5. SPECTRAL SCIENCES: LEAF SAMPLE, BOTTOM SIDE. PHI=90
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 2.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX D

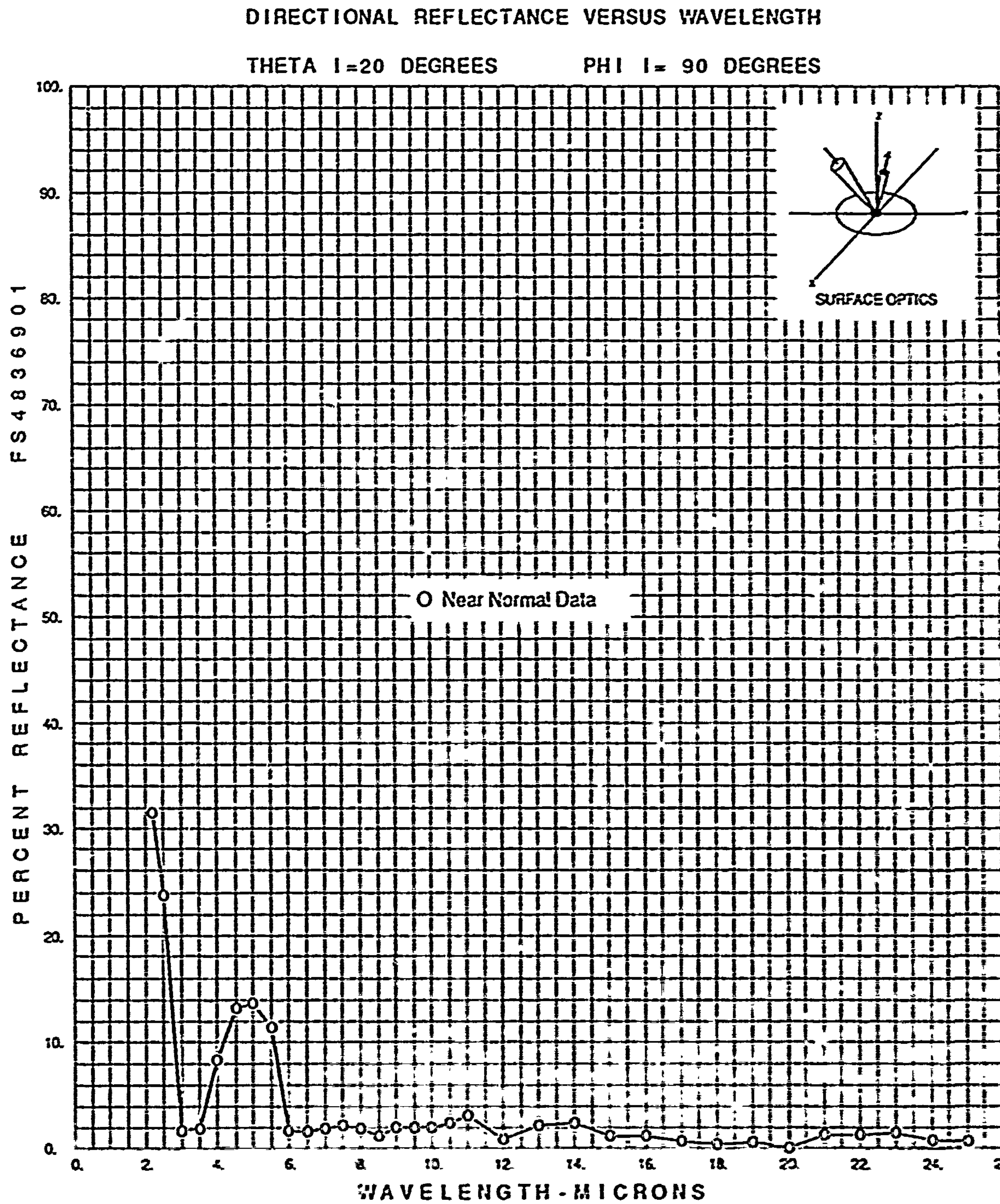

FIGURE D-6. SPECTRAL SCIENCES: LEAF SAMPLE,
BOTTOM SIDE. PHI=90
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 2.2 TO 25.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX D

TABLE D-2. SPECTRAL SCIENCES: LEAF SAMPLE, BOTTOM SIDE, PHI = 90 DIRECTIONAL REFLECTANCE VS. WAVELENGTH - ERAS DATA DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

FS48369015001		1	1								
FS48369015101		SPECTRAL SCIENCES: LEAF SAMPLE, BOTTOM SIDE. PHI=90									
FS48369015102		UNCORRECTED FOR INSTRUMENTATION POLARIZATION EFFECTS									
FS48369017001		101090									
FS48369019001	1	001	1	.3	25.	68				20.	90.
FS48369019201	1	.3	4.2	.375	5.4	.4	6.7	.45	14.2	.475	16.3
FS48369019202	1	.5	19.3	.525	26.4	.55	32.5	.575	32.9	.6	30.5
FS48369019203	1	.625	28.2	.65	25.3	.675	20.7	.7	37.6	.725	50.8
FS48369019204	1	.75	53.9	.8	53.7	.9	53.4	1.	53.1	1.1	52.3
FS48369019205	1	1.2	51.4	1.3	51.2	1.325	51.1	1.4	48.8	1.45	47.3
FS48369019206	1	1.5	47.2	1.6	46.8	1.65	46.7	1.7	45.6	1.75	44.5
FS48369019207	1	1.8	44.5	1.85	44.6	1.9	41.7	1.925	40.3	2.	37.8
FS48369019208	1	2.2	31.4	2.5	23.7	3.	1.7	3.5	1.9	4.	8.4
FS48369019209	1	4.5	13.2	5.	13.6	5.5	11.4	6.	1.7	6.5	1.6
FS48369019210	1	7.	1.9	7.5	2.1	8.	1.9	8.5	1.2	9.	2.0
FS48369019211	1	9.5	2.0	10.	2.0	10.5	2.4	11.	3.1	12.	0.9
FS48369019212	1	13.	2.1	14.	2.4	15.	1.2	16.	1.1	17.	0.7
FS48369019213	1	18.	0.4	19.	0.6	20.	0.0	21.	1.3	22.	1.3
FS48369019214	1	23.	1.5	24.	0.8	25.	0.7				

APPENDIX D

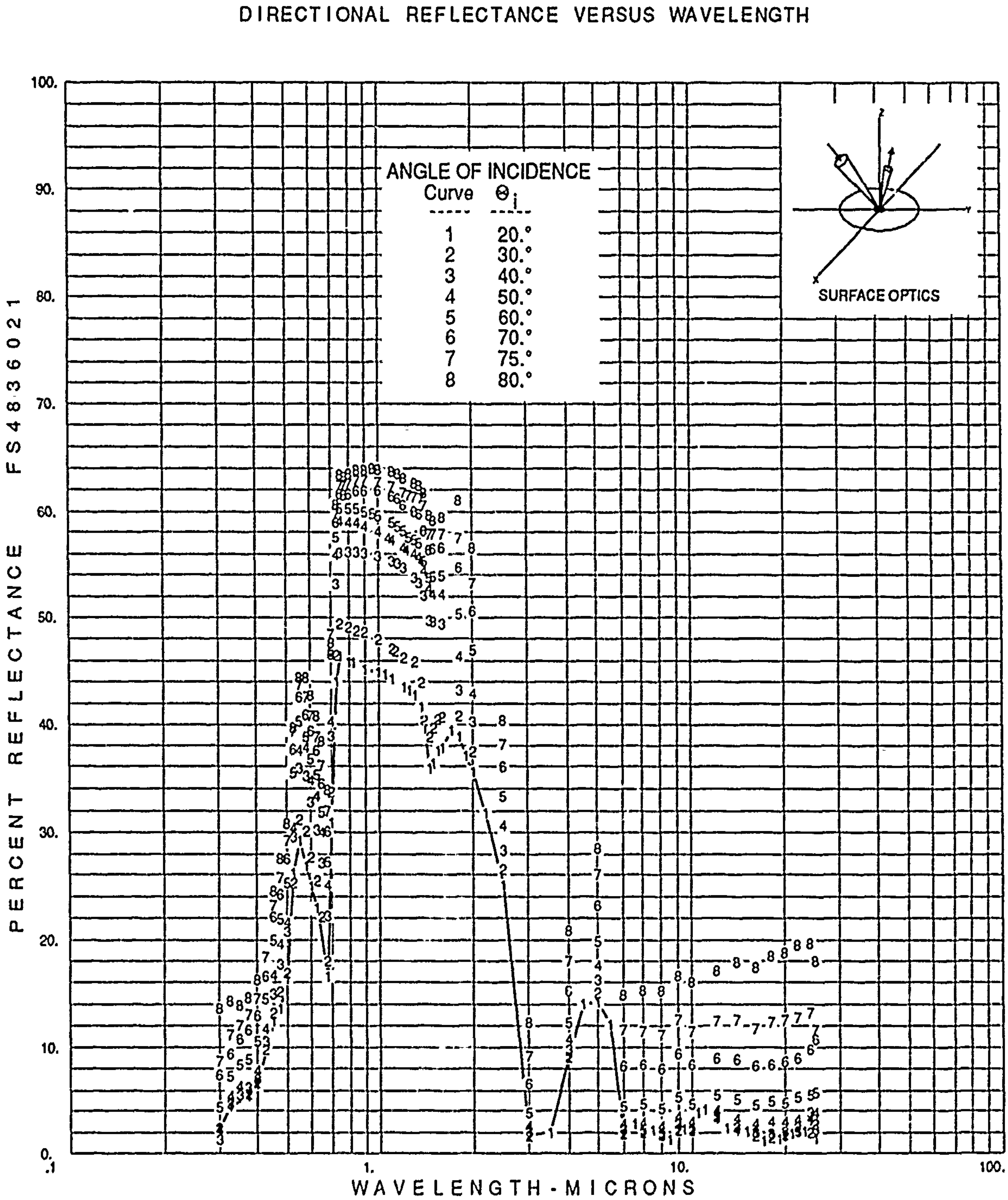

FIGURE D-7. SPECTRAL SCIENCES: LEAF SAMPLE, BOTTOM SIDE
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 25.0 MICROMETERS
DATA CORRECTED FOR INSTRUMENTATION POLARIZATION
DATA FROM 0.3 TO 1.6 MICROMETERS MEASURED
BEFORE DATA FROM 1.6 TO 25.0 MICROMETERS

APPENDIX D

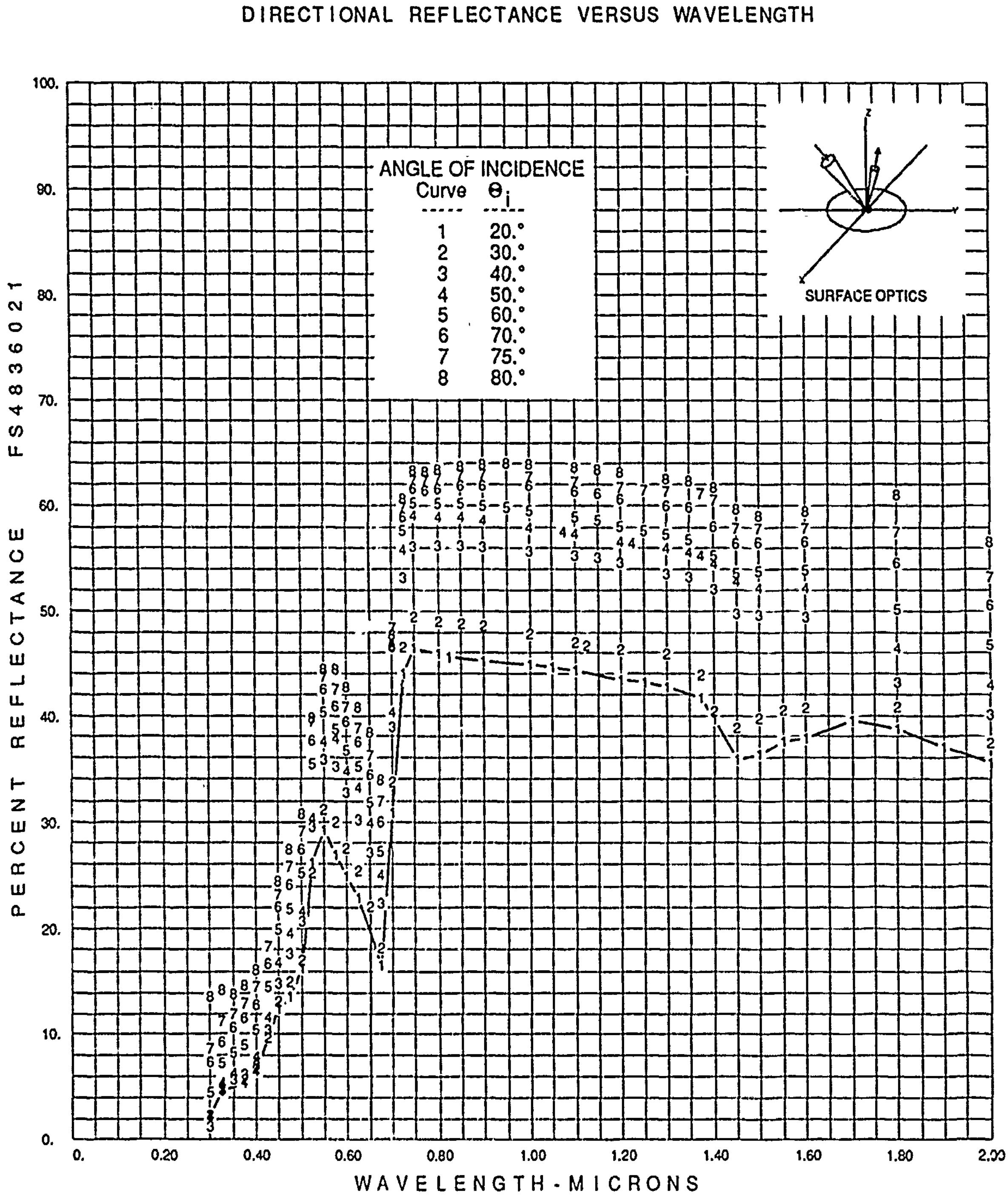

FIGURE D-8. SPECTRAL SCIENCES: LEAF SAMPLE, BOTTOM SIDE
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 2.0 MICROMETERS
DATA CORRECTED FOR INSTRUMENTATION POLARIZATION
DATA FROM 0.3 TO 1.6 MICROMETERS MEASURED
BEFORE DATA FROM 1.6 TO 25.0 MICROMETERS

APPENDIX D

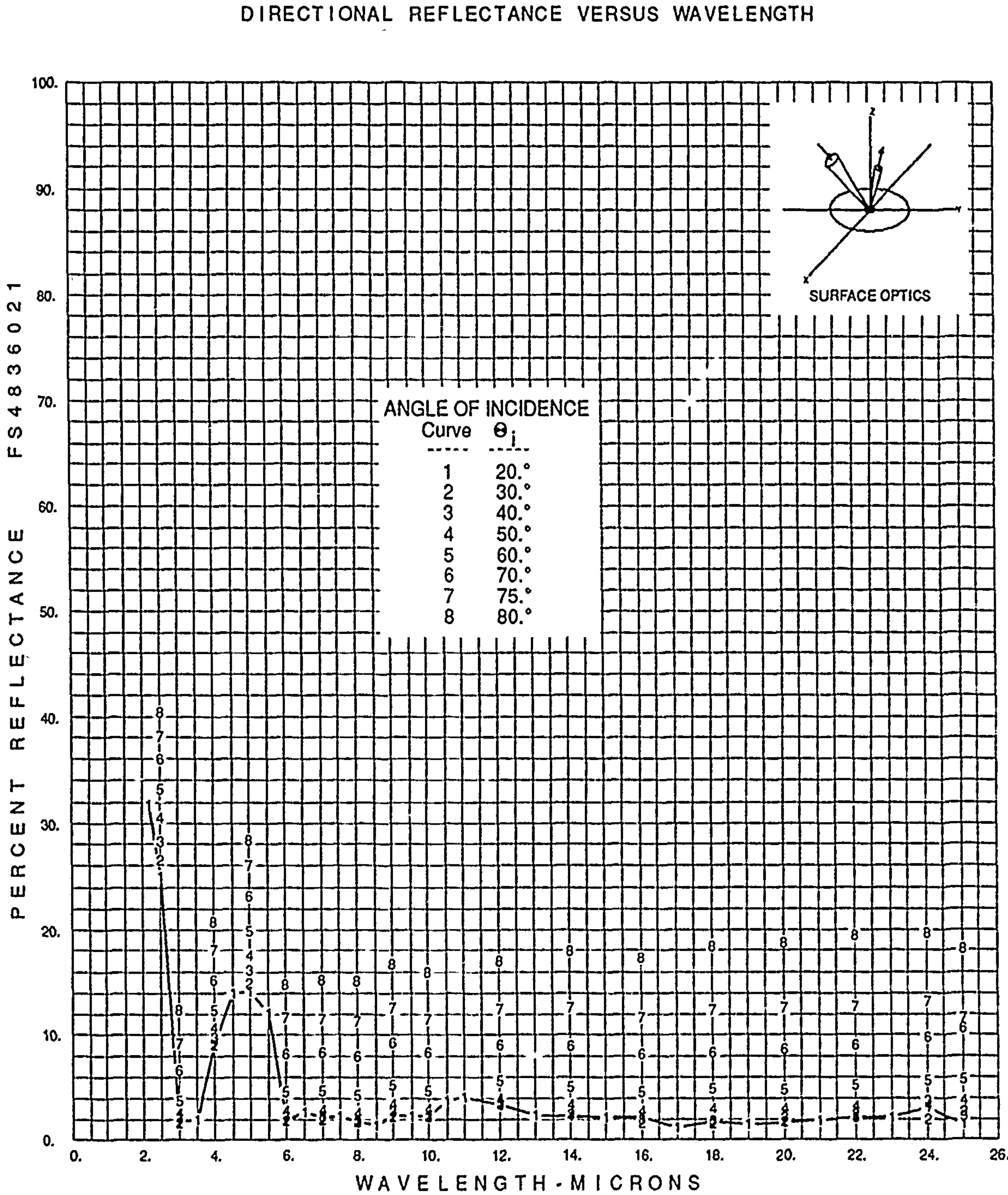

FIGURE D-9. SPECTRAL SCIENCES: LEAF SAMPLE, BOTTOM SIDE
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 2.2 TO 25.0 MICROMETERS
DATA CORRECTED FOR INSTRUMENTATION POLARIZATION
DATA FROM 0.3 TO 1.6 MICROMETERS MEASURED
BEFORE DATA FROM 1.6 TO 25.0 MICROMETERS

APPENDIX D

TABLE D-3. SPECTRAL SCIENCES: LEAF SAMPLE, BOTTOM SIDE. PHI = 0
DIRECTIONAL REFLECTANCE VS. WAVELENGTH - ERAS DATA
DATA CORRECTED FOR INSTRUMENTATION POLARIZATION
DATA FROM 0.3 TO 1.6 MICROMETERS MEASURED
BEFORE DATA FROM 1.6 TO 25.0 MICROMETERS

FS48360215001		8	1								
FS48360215101		SPECTRAL SCIENCES: LEAF SAMPLE, BOTTOM SIDE									
FS48360215102		CORRECTED FOR INSTRUMENTATION POLARIZATION EFFECTS									
FS48360217001		092890									
FS48360219001	1	001	1	.3	25.	68				20.	0.
FS48360219201	1	.3	2.3	.325	4.5	.375	5.4	.4	6.5	.45	12.4
FS48360219202	1	.475	13.6	.5	16.3	.525	26.2	.55	29.2	.575	26.9
FS48360219203	1	.6	24.9	.625	22.9	.675	16.6	.7	30.9	.725	44.0
FS48360219204	1	.75	46.4	.8	45.9	.825	45.7	.9	45.2	1.	44.9
FS48360219205	1	1.05	44.7	1.1	44.3	1.2	43.5	1.25	43.3	1.3	42.7
FS48360219206	1	1.375	41.7	1.4	39.6	1.45	35.8	1.5	36.4	1.55	37.6
FS48360219207	1	1.6	37.9	1.7	39.5	1.8	38.8	1.9	37.0	2.	35.6
FS48360219208	1	2.2	31.7	2.5	25.1	3.	1.8	3.5	2.0	4.	9.1
FS48360219209	1	4.5	14.0	5.	14.2	5.5	12.1	6.	1.9	6.5	2.7
FS48360219210	1	7.	2.1	7.5	2.2	8.	1.8	8.5	1.4	9.	2.4
FS48360219211	1	9.5	2.3	10.	2.3	10.5	3.8	11.	4.1	12.	3.3
FS48360219212	1	13.	2.4	14.	2.2	15.	2.1	16.	2.1	17.	1.2
FS48360219213	1	18.	1.8	19.	1.5	20.	1.7	21.	1.9	22.	2.1
FS48360219214	1	23.	2.1	24.	3.1	25.	1.5				
FS48360219001	2	001	1	.3	25.	51				30.	0.
FS48360219201	2	.3	2.4	.325	4.8	.375	5.7	.4	6.7	.425	9.7
FS48360219202	2	.45	13.2	.475	15.1	.5	17.0	.525	25.3	.55	31.2
FS48360219203	2	.575	30.1	.6	27.6	.625	25.5	.65	22.1	.675	18.1
FS48360219204	2	.7	33.7	.725	46.5	.75	49.4	.8	49.1	.85	48.8
FS48360219205	2	.9	48.6	1.	47.9	1.1	47.0	1.125	46.8	1.2	46.3
FS48360219206	2	1.3	45.9	1.375	43.9	1.4	40.4	1.45	38.9	1.5	39.7
FS48360219207	2	1.55	40.5	1.6	40.7	1.8	40.8	2.	37.4	2.5	26.6
FS48360219208	2	3.	1.7	4.	9.1	5.	15.0	6.	1.9	7.	2.0
FS48360219209	2	8.	1.8	9.	2.2	10.	2.2	12.	3.5	14.	2.5
FS48360219210	2	16.	1.7	18.	1.6	20.	1.8	22.	2.5	24.	2.0
FS48360219211	2	25.	2.7								
FS48360219001	3	001	1	.3	25.	51				40.	0.
FS48360219201	3	.3	1.3	.325	4.7	.35	5.6	.375	6.2	.4	7.1
FS48360219202	3	.425	10.5	.45	14.9	.475	17.7	.5	20.7	.525	29.6
FS48360219203	3	.55	35.8	.575	35.2	.6	32.7	.625	30.2	.65	27.1
FS48360219204	3	.675	22.3	.7	39.0	.725	53.2	.75	56.1	.8	56.2
FS48360219205	3	.85	56.2	.9	56.1	1.	55.8	1.1	55.3	1.15	55.1
FS48360219206	3	1.2	54.7	1.3	53.7	1.35	53.3	1.4	52.1	1.45	49.7
FS48360219207	3	1.5	49.6	1.6	49.4	1.8	43.3	2.	40.2	2.5	28.3
FS48360219208	3	3.	2.1	4.	9.8	5.	16.2	6.	2.3	7.	2.2
FS48360219209	3	8.	1.9	9.	2.8	10.	2.3	12.	3.6	14.	2.5
FS48360219210	3	16.	2.0	18.	1.9	20.	2.1	22.	2.1	24.	3.8
FS48360219211	3	25.	2.3								
FS48360219001	4	001	1	.3	25.	52				50.	0.
FS48360219201	4	.3	2.3	.325	5.4	.35	6.3	.4	7.8	.425	11.7
FS48360219202	4	.45	16.8	.475	19.6	.5	21.6	.525	30.3	.55	37.5
FS48360219203	4	.575	37.9	.6	34.7	.625	33.3	.65	30.0	.675	25.0
FS48360219204	4	.7	40.3	.725	55.9	.75	59.0	.8	58.9	.85	58.9

APPENDIX D

TABLE D-3. (CONTINUED)

FS48360219205	4	.9	58.6	1.	58.0	1.075	57.5	1.1	57.3	1.2	56.6
FS48360219206	4	1.225	56.4	1.3	56.0	1.35	55.7	1.375	55.3	1.4	54.5
FS48360219207	4	1.45	52.8	1.5	52.2	1.6	52.2	1.8	46.4	2.	42.9
FS48360219208	4	2.5	30.5	3.	2.6	4.	10.7	5.	17.6	6.	2.8
FS48360219209	4	7.	2.9	8.	2.6	9.	3.5	10.	3.0	12.	4.0
FS48360219210	4	14.	3.3	16.	2.8	18.	3.0	20.	3.0	22.	3.2
FS48360219211	4	24.	3.3	25.	3.8						
FS48360219001	5	001	1	.3	25.	53				60.	0.
FS48360219201	5	.3	4.4	.325	7.3	.35	8.3	.375	8.9	.4	10.5
FS48360219202	5	.425	14.5	.45	20.0	.475	21.9	.5	25.3	.525	35.5
FS48360219203	5	.55	40.3	.575	38.8	.6	36.8	.625	35.3	.65	31.8
FS48360219204	5	.675	27.2	.7	46.8	.725	57.6	.75	60.2	.8	60.2
FS48360219205	5	.85	60.2	.9	60.0	.95	59.8	1.	59.5	1.1	58.9
FS48360219206	5	1.15	58.6	1.2	58.1	1.25	57.6	1.3	57.3	1.35	56.9
FS48360219207	5	1.4	55.3	1.45	53.7	1.5	53.8	1.6	53.9	1.8	50.3
FS48360219208	5	2.	46.9	2.5	33.3	3.	3.8	4.	12.3	5.	19.9
FS48360219209	5	6.	4.5	7.	4.7	8.	4.3	9.	5.3	10.	4.7
FS48360219210	5	12.	5.6	14.	5.1	16.	4.6	18.	4.9	20.	4.8
FS48360219211	5	22.	5.3	24.	5.6	25.	5.8				
FS48360219001	6	001	1	.3	25.	52				70.	0.
FS48360219201	6	.3	7.4	.325	9.3	.35	10.7	.375	11.6	.4	12.9
FS48360219202	6	.425	16.7	.45	22.1	.475	24.2	.5	27.5	.525	37.7
FS48360219203	6	.55	42.5	.575	40.9	.6	39.4	.625	37.5	.65	34.5
FS48360219204	6	.675	30.1	.7	46.6	.725	58.9	.75	61.6	.775	61.5
FS48360219205	6	.8	61.6	.85	61.9	.9	61.9	1.	61.9	1.1	61.4
FS48360219206	6	1.15	61.1	1.2	60.6	1.3	60.0	1.35	59.8	1.4	58.1
FS48360219207	6	1.45	56.4	1.5	56.5	1.6	56.6	1.8	54.7	2.	50.6
FS48360219208	6	2.5	36.0	3.	6.6	4.	15.3	5.	23.2	6.	8.2
FS48360219209	6	7.	8.4	8.	8.0	9.	9.3	10.	8.4	12.	9.0
FS48360219210	6	14.	8.9	16.	8.2	18.	8.4	20.	8.7	22.	9.0
FS48360219211	6	24.	9.8	25.	10.7						
FS48360219001	7	001	1	.3	25.	52				75.	0.
FS48360219201	7	.3	8.7	.325	11.2	.35	12.0	.375	13.0	.4	14.5
FS48360219202	7	.425	18.4	.45	23.2	.475	25.8	.5	29.1	.525	39.4
FS48360219203	7	.55	43.7	.575	42.5	.6	40.8	.625	38.9	.65	36.2
FS48360219204	7	.675	32.0	.7	48.4	.725	59.8	.75	62.3	.775	62.4
FS48360219205	7	.8	62.6	.85	62.9	.9	62.9	1.	62.7	1.1	62.2
FS48360219206	7	1.2	61.7	1.25	61.5	1.3	61.3	1.375	61.1	1.4	60.5
FS48360219207	7	1.45	57.8	1.5	57.8	1.6	57.8	1.8	57.5	2.	53.3
FS48360219208	7	2.5	38.1	3.	9.2	4.	18.0	5.	26.0	6.	11.6
FS48360219209	7	7.	11.5	8.	11.2	9.	12.5	10.	11.5	12.	12.4
FS48360219210	7	14.	12.5	16.	11.7	18.	12.3	20.	12.5	22.	12.7
FS48360219211	7	24.	13.2	25.	11.6						
FS48360219001	8	001	1	.3	25.	52				80.	0.
FS48360219201	8	.3	13.6	.325	14.3	.35	13.9	.375	14.6	.4	16.2
FS48360219202	8	.45	24.5	.475	27.5	.5	30.8	.525	39.7	.55	44.5
FS48360219203	8	.575	44.5	.6	42.7	.625	40.8	.65	38.4	.675	33.9
FS48360219204	8	.7	47.7	.725	60.6	.75	63.3	.775	63.2	.8	63.4

TABLE D-3. (CONTINUED)

FS48360219205	8	.85	63.8	.9	63.9	.95	64.0	1.	63.9	1.1	63.6
FS48360219206	8	1.15	63.4	1.2	63.1	1.3	62.6	1.35	62.3	1.4	61.7
FS48360219207	8	1.45	59.6	1.5	59.1	1.6	59.4	1.8	61.0	2.	56.6
FS48360219208	8	2.5	40.4	3.	12.3	4.	20.8	5.	28.5	6.	14.8
FS48360219209	8	7.	15.3	8.	15.2	9.	16.7	10.	16.0	12.	17.1
FS48360219210	8	14.	17.9	16.	17.4	18.	18.5	20.	18.8	22.	19.5
FS48360219211	8	24.	19.7	25.	18.1						

APPENDIX D

TABLE D-4. SPECTRAL SCIENCES: LEAF SAMPLE, BOTTOM SIDE
DIRECTIONAL EMITTANCE AS A FUNCTION OF TEMPERATURE
DATA CORRECTED FOR INSTRUMENTATION POLARIZATION
DATA CORRECTED FOR MATERIAL TRANSMISSION

FS4836021: SPECTRAL SCIENCES: LEAF SAMPLE, BOTTOM SIDE
CORRECTED FOR INSTRUMENTATION POLARIZATION EFFECTS

Emittance tabulated as a function of temperature:

Zenith angle (degrees)	Wavelength range (microns)	Temperature (degrees Kelvin) 100	200	300	400	500	600
20	0.300 - 25.000	0.979	0.975	0.965	0.944	0.922	0.900

DATA CORRECTED FOR MATERIAL TRANSMISSION

TABLE D-5. SPECTRAL SCIENCES: LEAF SAMPLE, BOTTOM SIDE
SOLAR ABSORPTANCE
DATA CORRECTED FOR INSTRUMENTATION POLARIZATION
DATA CORRECTED FOR MATERIAL TRANSMISSION

```
FS4836021                                    Surface Optics Corp.
SPECTRAL SCIENCES: LEAF SAMPLE, BOTTOM SIDE

20 degrees: The exoatmospheric solar absorptance is 0.453.

DATA CORRECTED FOR MATERIAL TRANSMISSION
```

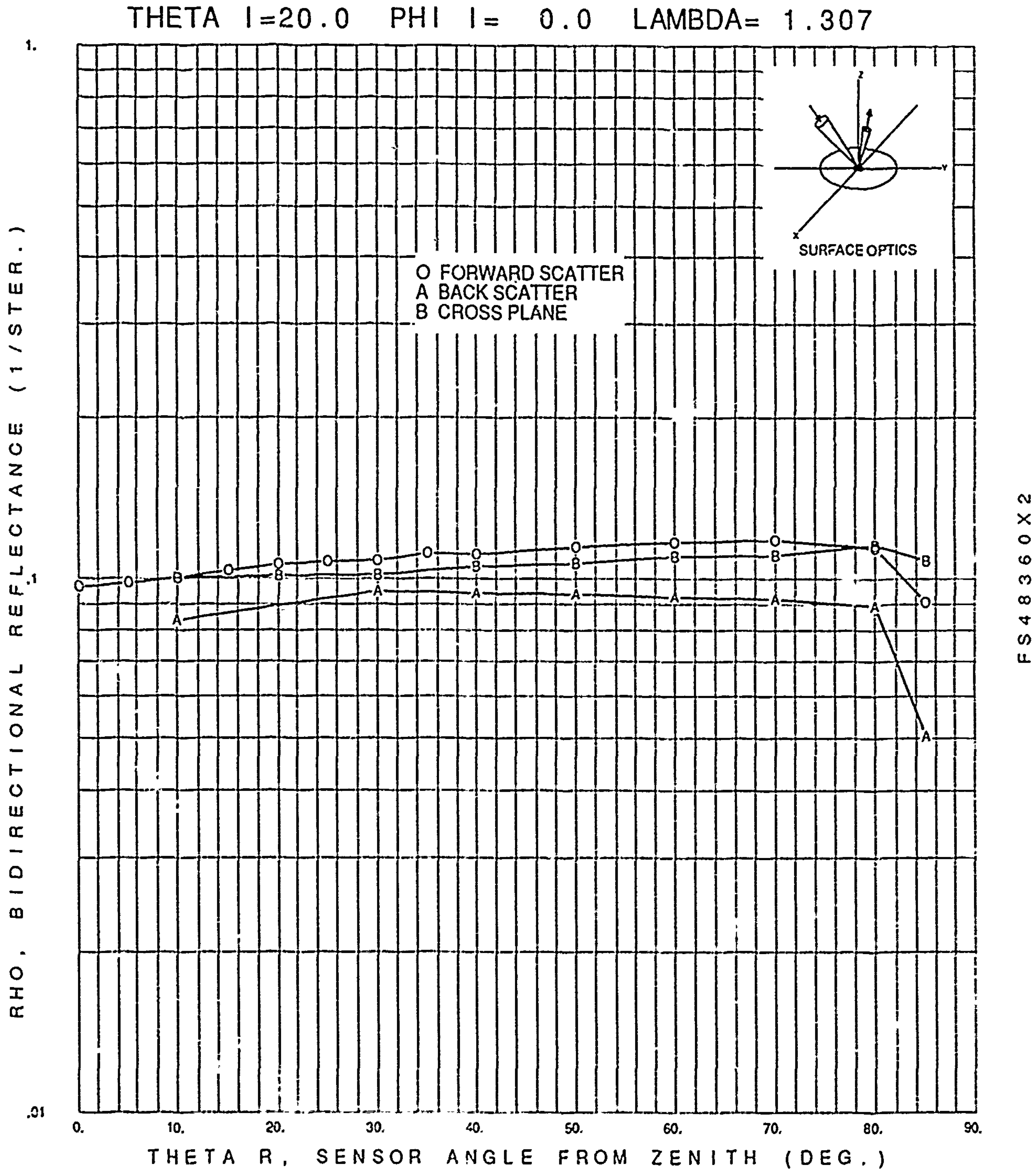

FIGURE D-10. SPECTRAL SCIENCES: LEAF SAMPLE, BOTTOM SIDE
BIDIRECTIONAL REFLECTANCE VS. REFLECTED POLAR ANGLE
WAVELENGTH 1.307 MICROMETERS
INCIDENT POLAR ANGLE 20.0 DEGREES

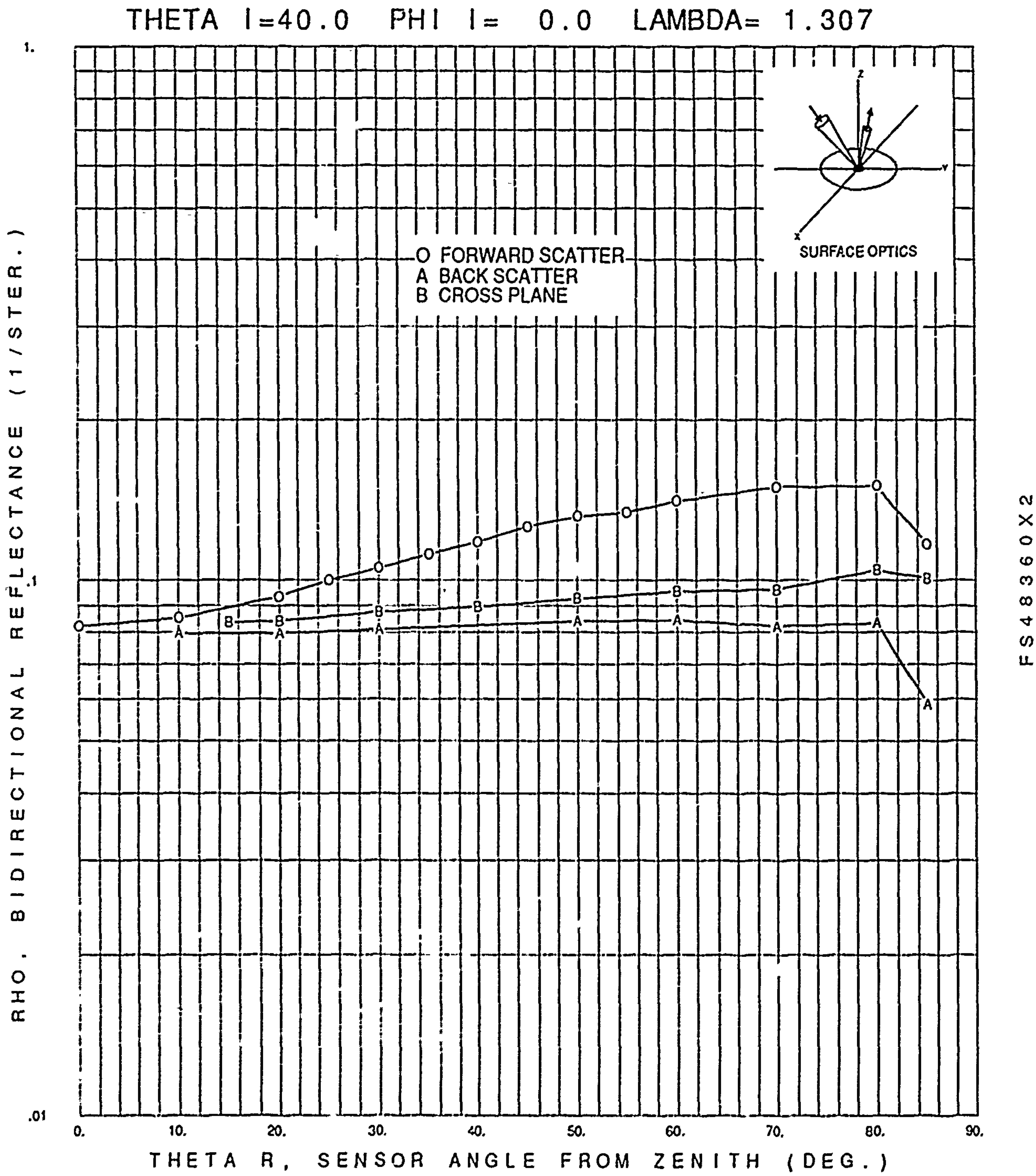

FIGURE D-11. SPECTRAL SCIENCES: LEAF SAMPLE, BOTTOM SIDE
BIDIRECTIONAL REFLECTANCE VS. REFLECTED POLAR ANGLE
WAVELENGTH 1.307 MICROMETERS
INCIDENT POLAR ANGLE 40.0 DEGREES

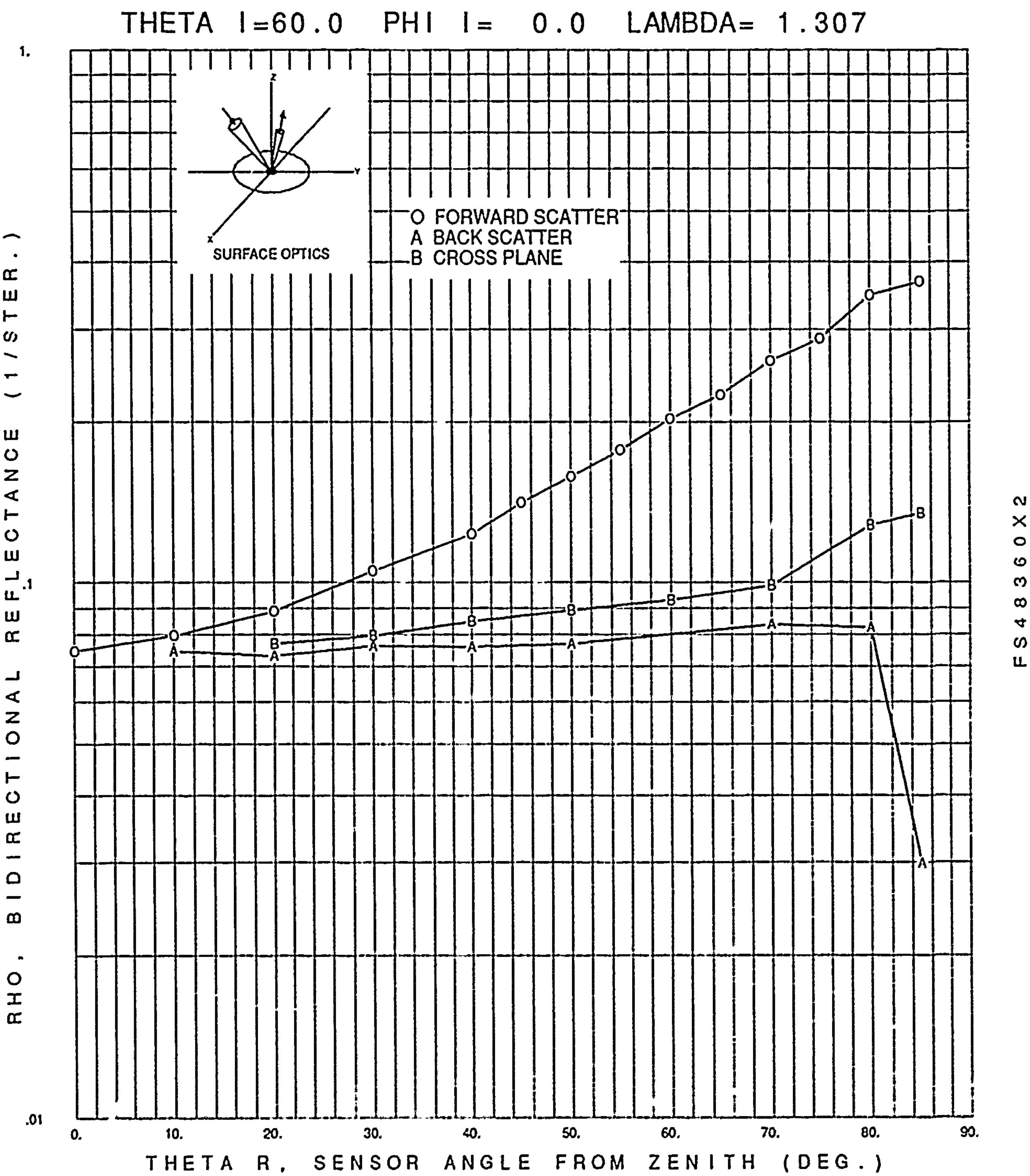

FIGURE D-12. SPECTRAL SCIENCES: LEAF SAMPLE, BOTTOM SIDE
BIDIRECTIONAL REFLECTANCE VS. REFLECTED POLAR ANGLE
WAVELENGTH 1.307 MICROMETERS
INCIDENT POLAR ANGLE 60.0 DEGREES

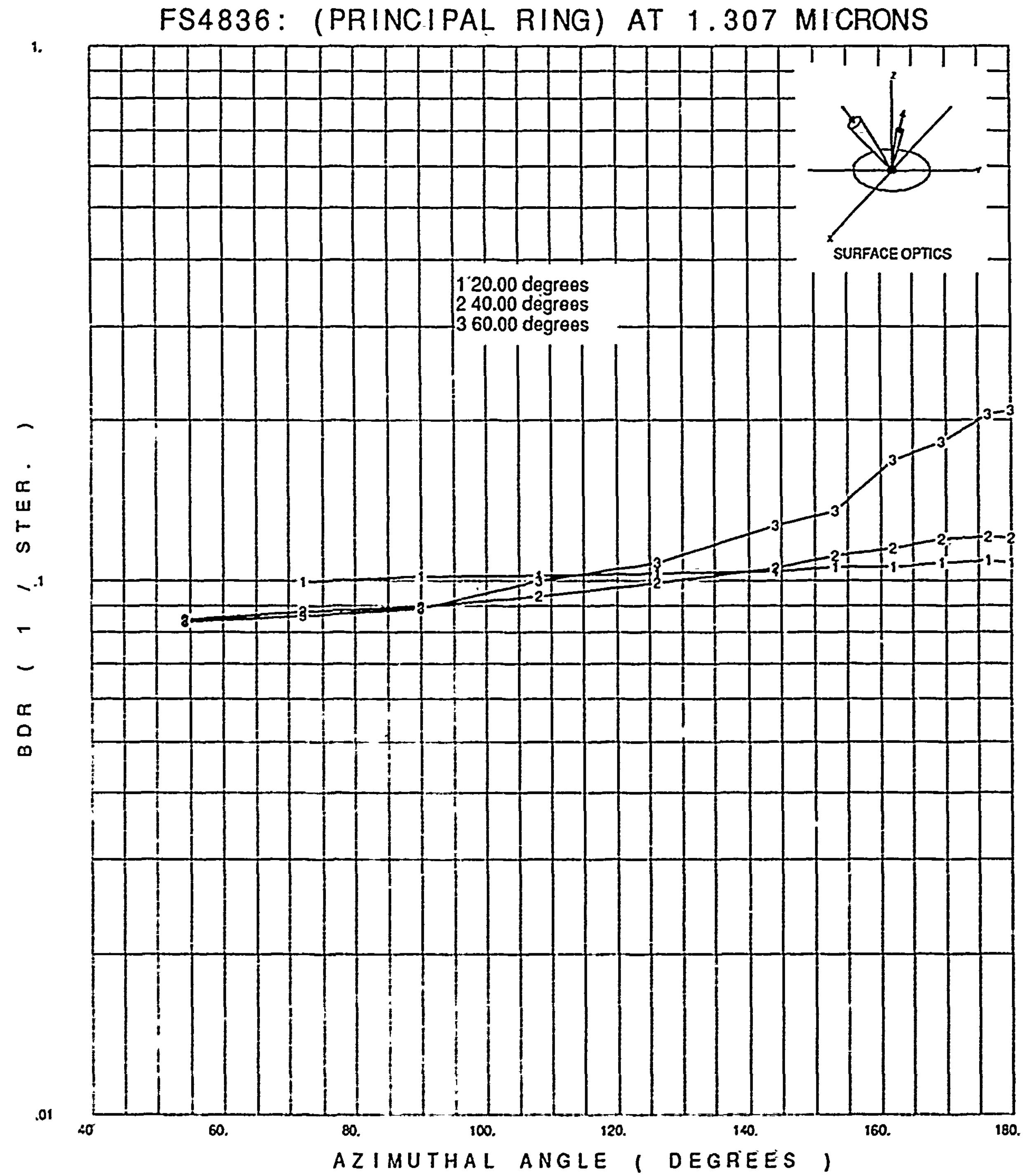

FIGURE D-13: SPECTRAL SCIENCES: LEAF SAMPLE, BOTTOM SIDE
BIDIRECTIONAL REFLECTANCE VS. REFLECTED AZIMUTH ANGLE
PRINCIPAL RING AT 1.307 MICROMETERS
INCIDENT POLAR ANGLES 20, 40 AND 60 DEGREES

APPENDIX D

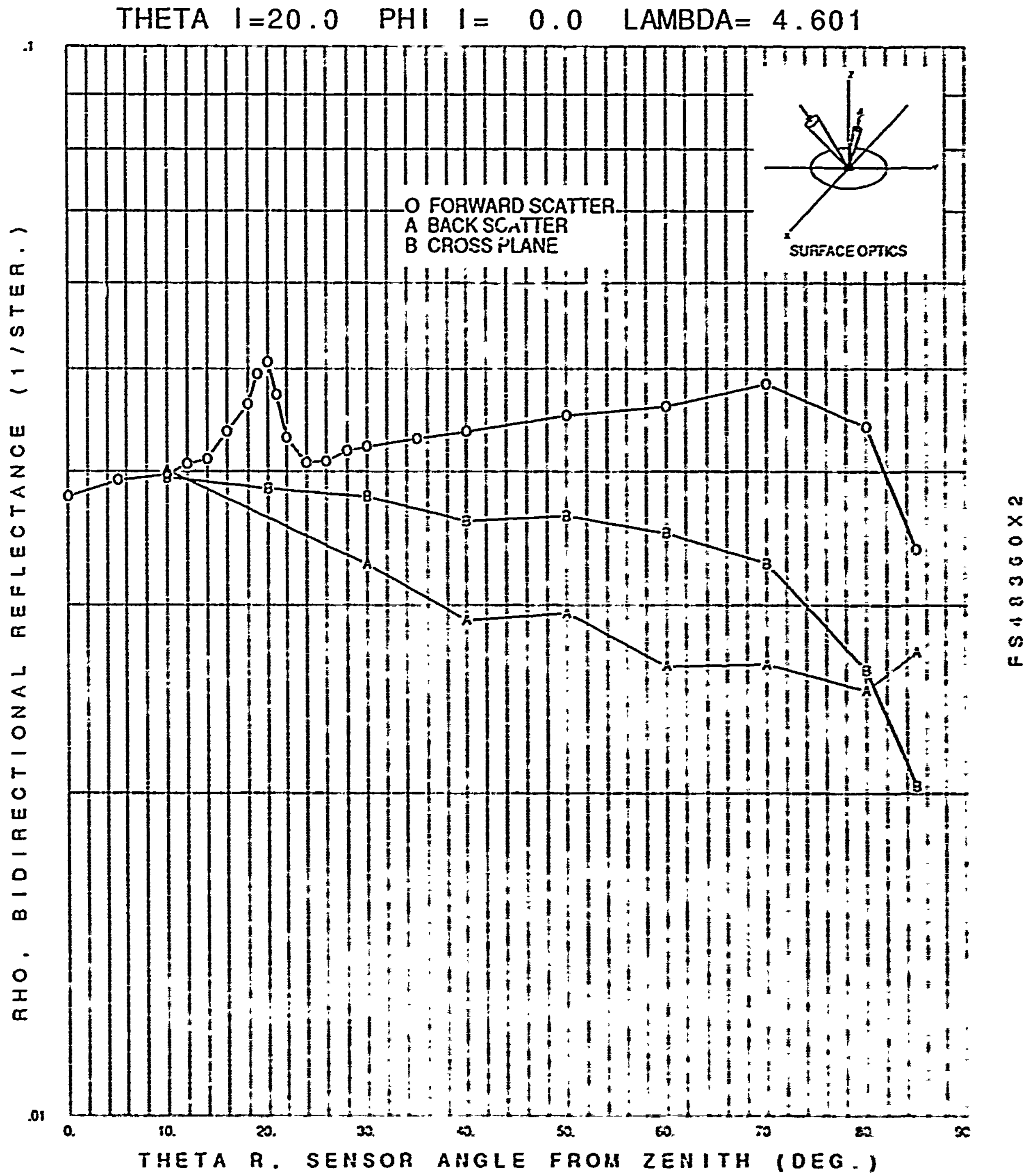

FIGURE D-14. SPECTRAL SCIENCES: LEAF SAMPLE, BOTTOM SIDE
BIDIRECTIONAL REFLECTANCE VS. REFLECTED POLAR ANGLE
WAVELENGTH 4.601 MICROMETERS
INCIDENT POLAR ANGLE 20.0 DEGREES

APPENDIX D

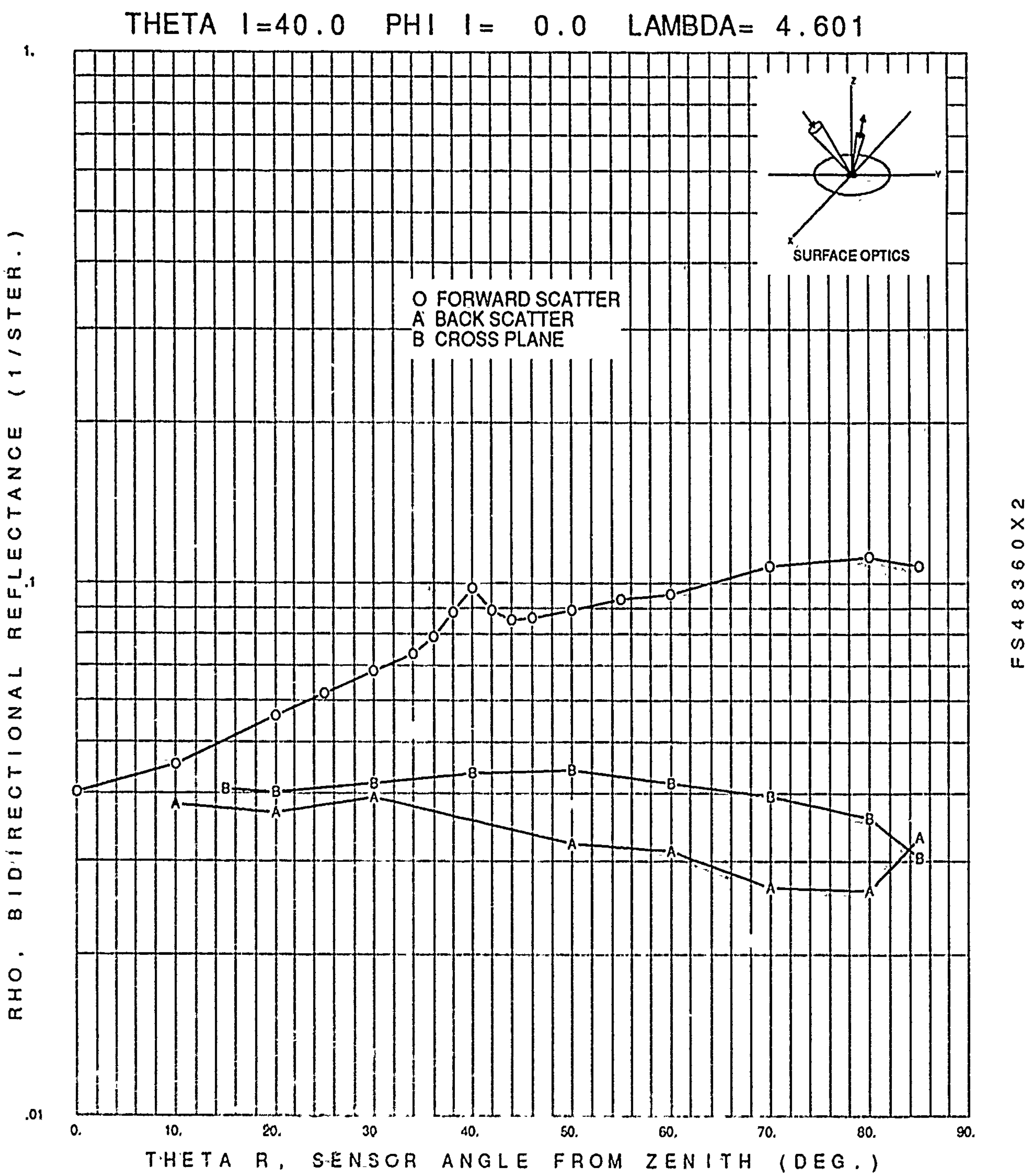

FIGURE D-15. SPECTRAL SCIENCES: LEAF SAMPLE, BOTTOM SIDE
BIDIRECTIONAL REFLECTANCE VS. REFLECTED POLAR ANGLE
WAVELENGTH 4.601 MICROMETERS
INCIDENT POLAR ANGLE 40.0 DEGREES

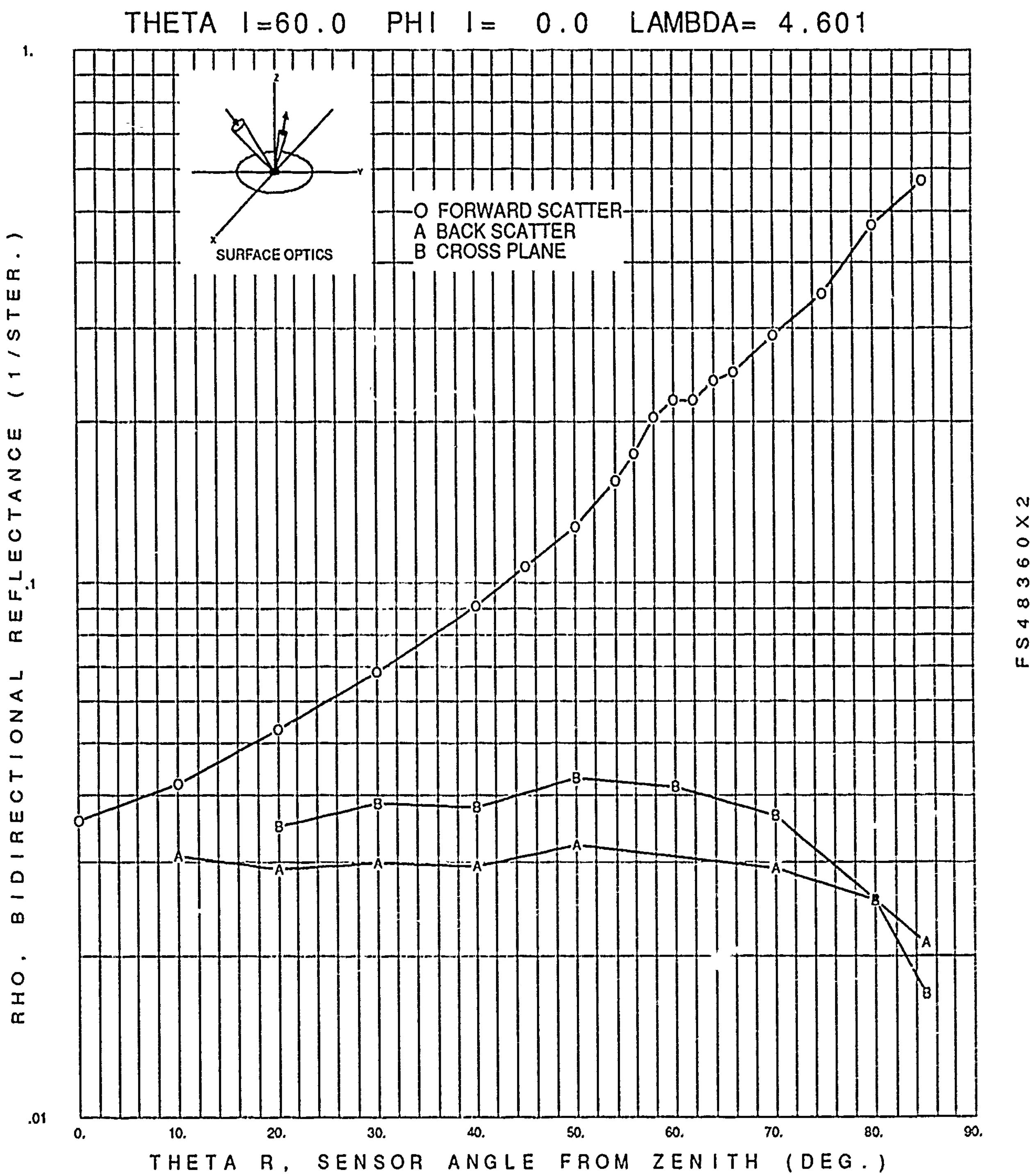

FIGURE D-16. SPECTRAL SCIENCES: LEAF SAMPLE, BOTTOM SIDE
BIDIRECTIONAL REFLECTANCE VS. REFLECTED POLAR ANGLE
WAVELENGTH 4.601 MICROMETERS
INCIDENT POLAR ANGLE 60.0 DEGREES

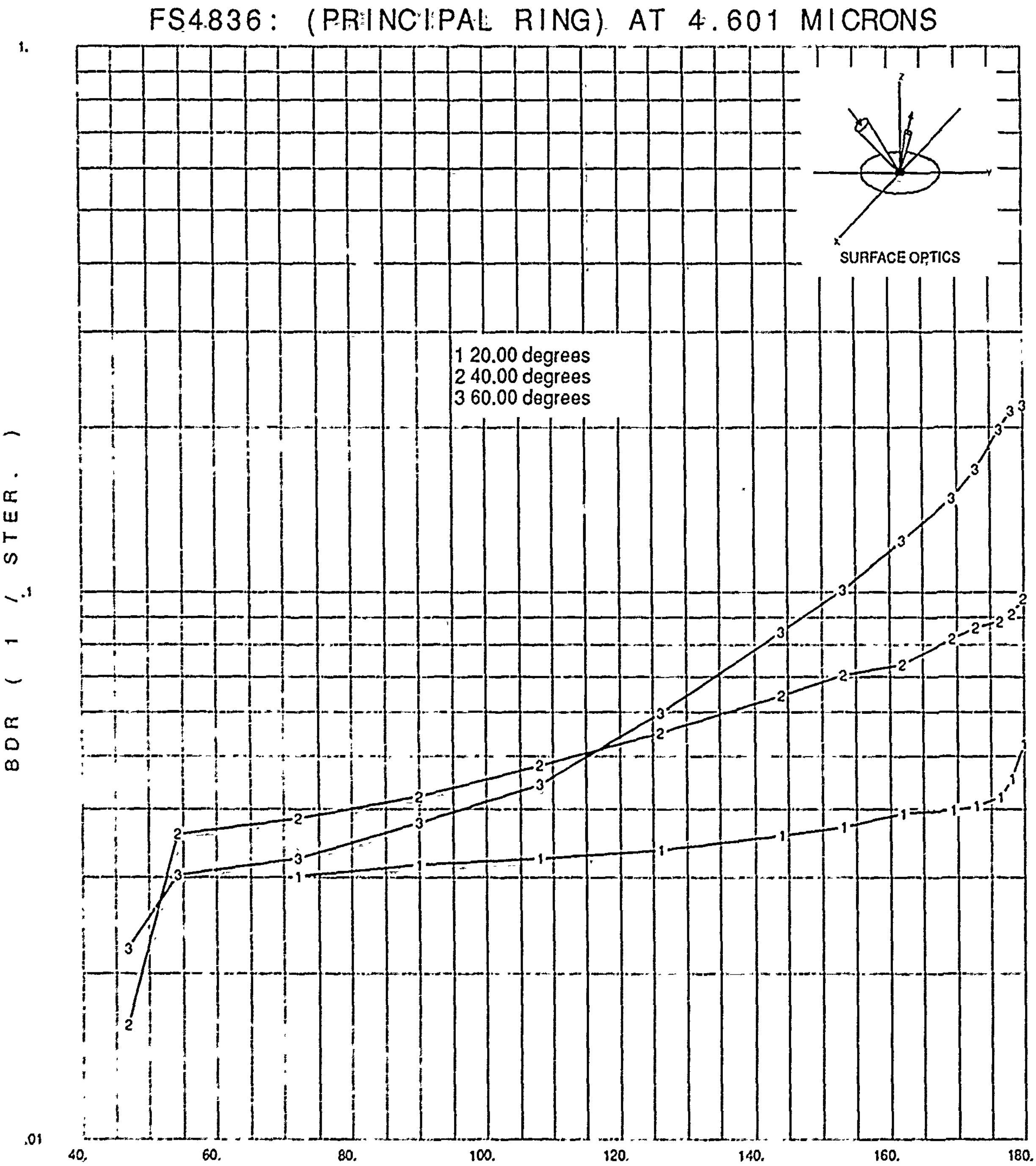

FIGURE D-17. SPECTRAL SCIENCES: LEAF SAMPLE, BOTTOM SIDE
BIDIRECTIONAL REFLECTANCE VS. REFLECTED AZIMUTH ANGLE
PRINCIPAL RING AT 4.601 MICROMETERS
INCIDENT POLAR ANGLES 20, 40 AND 60 DEGREES

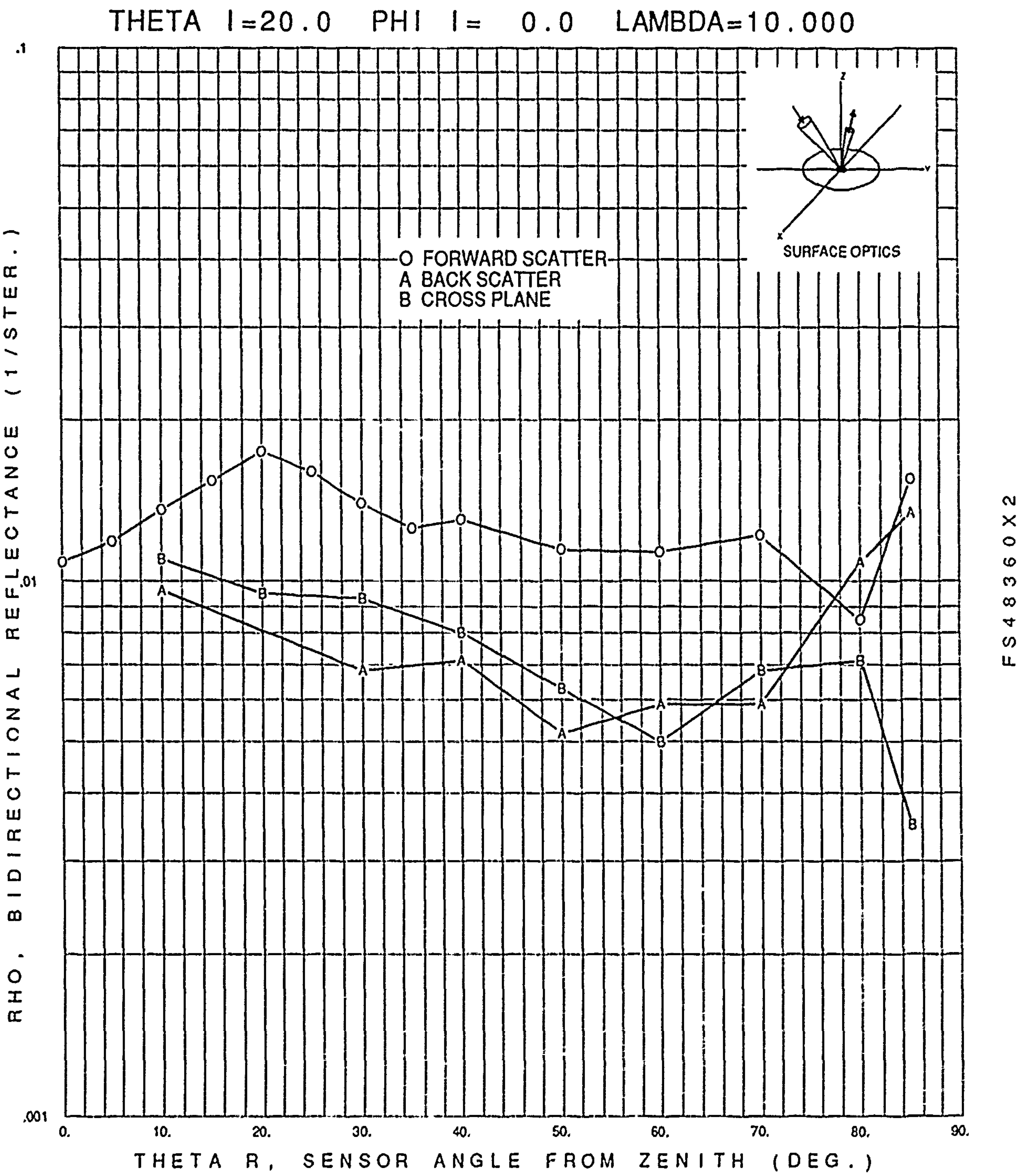

FIGURE D-18. SPECTRAL SCIENCES: LEAF SAMPLE, BOTTOM SIDE
BIDIRECTIONAL REFLECTANCE VS. REFLECTED POLAR ANGLE
WAVELENGTH 10.000 MICROMETERS
INCIDENT POLAR ANGLE 20.0 DEGREES

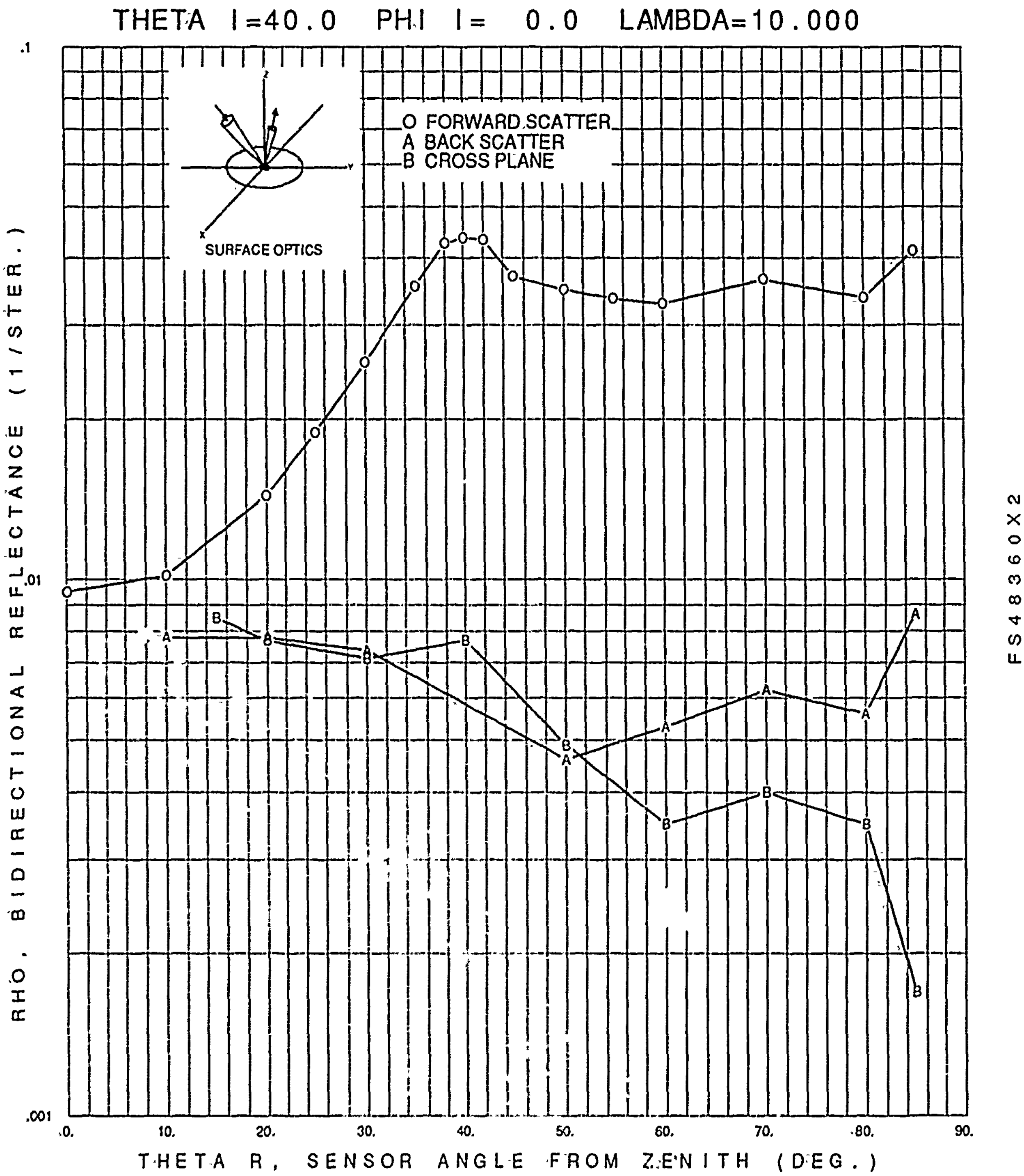

FIGURE D-19. SPECTRAL SCIENCES: LEAF SAMPLE, BOTTOM SIDE
BIDIRECTIONAL REFLECTANCE VS. REFLECTED POLAR ANGLE
WAVELENGTH 10.000 MICROMETERS
INCIDENT POLAR ANGLE 40.0 DEGREES

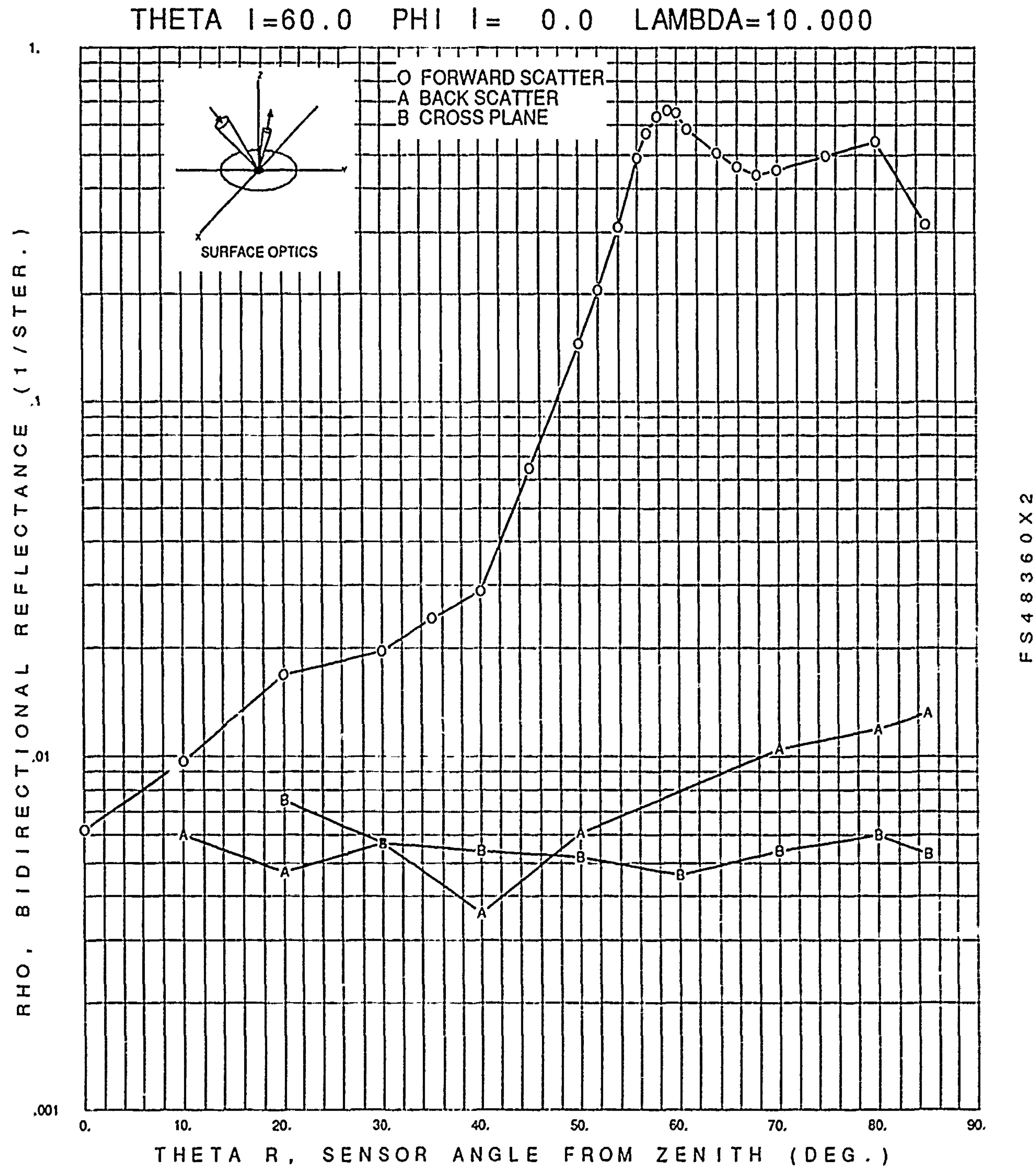

FIGURE D-20. SPECTRAL SCIENCES: LEAF SAMPLE, BOTTOM SIDE
BIDIRECTIONAL REFLECTANCE VS. REFLECTED POLAR ANGLE
WAVELENGTH 10.000 MICROMETERS
INCIDENT POLAR ANGLE 60.0 DEGREES

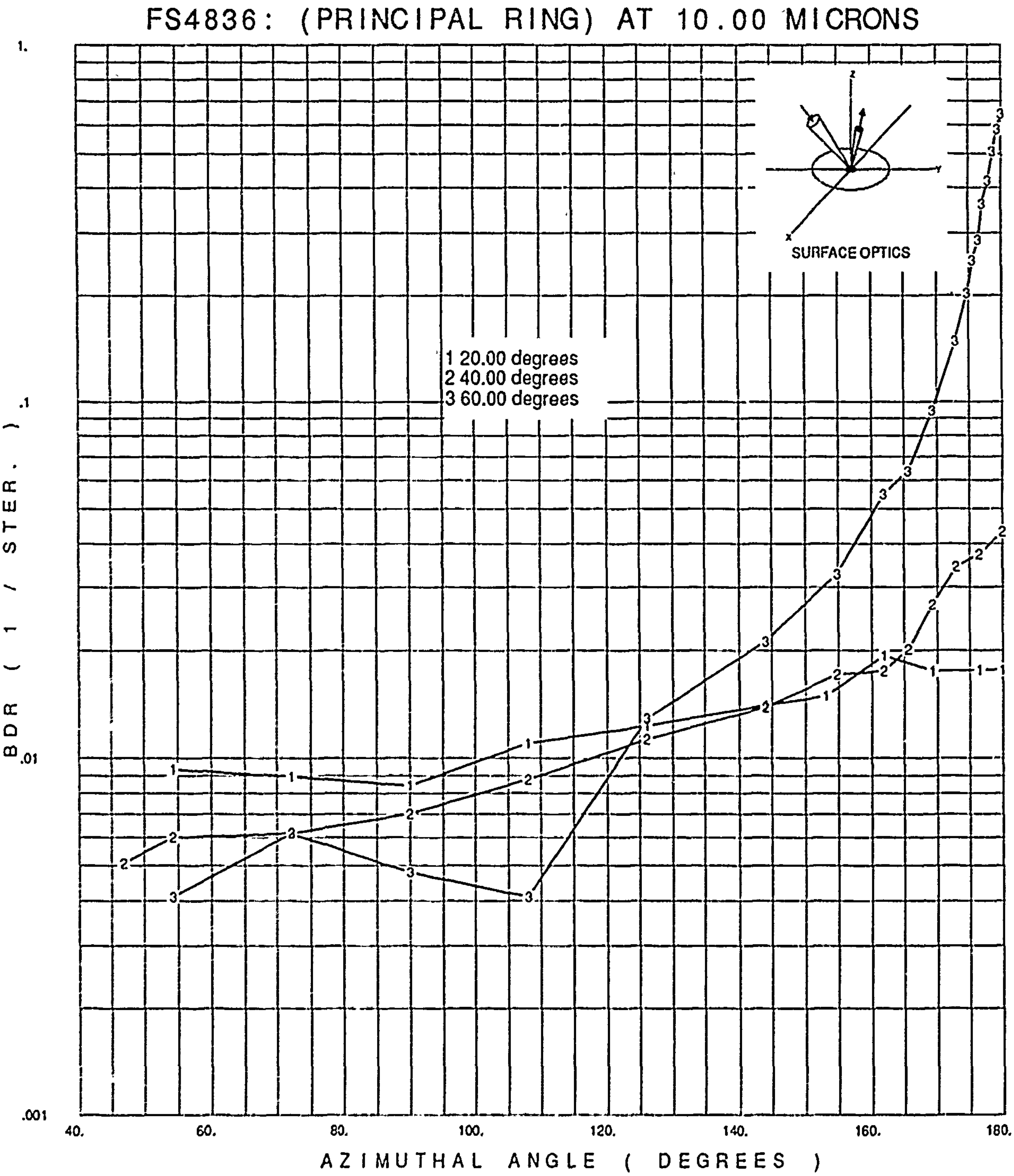

FIGURE D-21. SPECTRAL SCIENCES: LEAF SAMPLE, BOTTOM SIDE
BIDIRECTIONAL REFLECTANCE VS. REFLECTED AZIMUTH ANGLE
PRINCIPAL RING AT 10.00 MICROMETERS
INCIDENT POLAR ANGLES 20, 40 AND 60 DEGREES

APPENDIX D

TABLE D-6. SPECTRAL SCIENCES: LEAF SAMPLE, BOTTOM SIDE. PHI = 0
BIDIRECTIONAL REFLECTANCE VS. REFLECTED POLAR ANGLE
ERAS DATA
WAVELENGTH 1.307, 4.601, 10 MICROMETERS
INCIDENT POLAR ANGLES 20, 40, 60 DEGREES

FS48360X25001		36	013								
FS48360X25101		SPECTRAL SCIENCES: LEAF SAMPLE, BOTTOM SIDE									
FS48360X27004						760.					
FS48360X29001	1		4 10	0.0	85.0	14	1.307	20.0	0.0		180.0
FS48360X29201	1	0.0	.0968	5.0	.0986	10.0	.1007	15.0	.1038	20.0	.1062
FS48360X29202	1	25.0	.1081	30.0	.1083	35.0	.1117	40.0	.1113	50.0	.115
FS48360X29203	1	60.0	.1174	70.0	.1182	80.0	.1145	85.0	.0902		
FS48360X29001	2		4 10	10.0	85.0	8	1.307	20.0	0.0		0.0
FS48360X29201	2	10.0	.0838	30.0	.0947	40.0	.0944	50.0	.0938	60.0	.0924
FS48360X29202	2	70.0	.0919	80.0	.0892	85.0	.0504				
FS48360X29001	3		4 10	10.0	85.0	9	1.307	20.0	0.0		90.0
FS48360X29201	3	10.0	.1007	20.0	.1016	30.0	.1019	40.0	.1056	50.0	.1071
FS48360X29202	3	60.0	.11	70.0	.1108	80.0	.1158	85.0	.1087		
FS48360X29001	4		5 10	72.0	180.0	10	1.307	20.0	0.0	20.0	
FS48360X29201	4	72.0	.0996	90.0	.1013	108.0	.1021	126.0	.1028	144.0	.1038
FS48360X29202	4	153.0	.106	162.0	.1062	169.2	.1075	176.4	.1087	180.0	.1077
FS48360X29001	5		4 10	0.0	85.0	14	1.307	40.0	0.0		180.0
FS48360X29201	5	0.0	.0819	10.0	.0852	20.0	.0935	25.0	.0998	30.0	.1054
FS48360X29202	5	35.0	.1121	40.0	.1184	45.0	.1263	50.0	.1319	55.0	.1344
FS48360X29203	5	60.0	.1406	70.0	.15	80.0	.1502	85.0	.1171		
FS48360X29001	6		4 10	10.0	85.0	8	1.307	40.0	0.0		0.0
FS48360X29201	6	10.0	.0797	20.0	.0796	30.0	.0812	50.0	.0842	60.0	.0845
FS48360X29202	6	70.0	.0821	80.0	.0833	85.0	.0586				
FS48360X29001	7		4 10	15.0	85.0	9	1.307	40.0	0.0		90.0
FS48360X29201	7	15.0	.0836	20.0	.0842	30.0	.0874	40.0	.0896	50.0	.0926
FS48360X29202	7	60.0	.0953	70.0	.0962	80.0	.1045	85.0	.1008		
FS48360X29001	8		5 10	54.0	180.0	11	1.307	40.0	0.0	40.0	
FS48360X29201	8	54.0	.0844	72.0	.0873	90.0	.0896	108.0	.0933	126.0	.0992
FS48360X29202	8	144.0	.1055	153.0	.111	162.0	.1147	169.2	.1188	176.4	.1203
FS48360X29203	8	180.0	.1195								
FS48360X29001	9		4 10	0.0	85.0	14	1.307	60.0	0.0		180.0
FS48360X29201	9	0.0	.0747	10.0	.0798	20.0	.0887	30.0	.1048	40.0	.123
FS48360X29202	9	45.0	.1407	50.0	.1581	55.0	.1772	60.0	.2033	65.0	.2251
FS48360X29203	9	70.0	.2616	75.0	.2886	80.0	.3477	85.0	.3688		
FS48360X29001	10		4 10	10.0	85.0	8	1.307	60.0	0.0		0.0
FS48360X29201	10	10.0	.0745	20.0	.073	30.0	.0762	40.0	.076	50.0	.077
FS48360X29202	10	70.0	.0838	80.0	.0825	85.0	.0299				
FS48360X29001	11		4 10	20.0	85.0	8	1.307	60.0	0.0		90.0
FS48360X29201	11	20.0	.0772	30.0	.0797	40.0	.0851	50.0	.0892	60.0	.093
FS48360X29202	11	70.0	.0991	80.0	.1276	85.0	.1345				
FS48360X29001	12		5 10	54.0	180.0	11	1.307	60.0	0.0	60.0	
FS48360X29201	12	54.0	.0834	72.0	.086	90.0	.0886	108.0	.0999	126.0	.1077
FS48360X29202	12	144.0	.126	153.0	.1346	162.0	.1676	169.2	.1815	176.4	.2041
FS48360X29203	12	180.0	.2076								
FS48360X29001	13		4 10	0.0	85.0	22	4.601	20.0	0.0		180.0
FS48360X29201	13	0.0	.0379	5.0	.0393	10.0	.0397	12.0	.0406	14.0	.0411
FS48360X29202	13	16.0	.0435	18.0	.0463	19.0	.0493	20.0	.0506	21.0	.0472
FS48360X29203	13	22.0	.043	24.0	.0407	26.0	.0409	28.0	.0418	30.0	.0422

APPENDIX D

TABLE D-6. (CONTINUED)

FS48360X29204	13	35.0	.0429	40.0	.0436	50.0	.0452	60.0	.046	70.0	.0483
FS48360X29205	13	80.0	.0441	85.0	.0338						
FS48360X29001	14		4 10	10.0	85.0	8	4.601	20.0	0.0		0.0
FS48360X29201	14	10.0	.0401	30.0	.0327	40.0	.029	50.0	.0294	60.0	.0263
FS48360X29202	14	70.0	.0264	80.0	.0249	85.0	.0271				
FS48360X29001	15		4 10	10.0	85.0	9	4.601	20.0	0.0		90.0
FS48360X29201	15	10.0	.0395	20.0	.0385	30.0	.0379	40.0	.0359	50.0	.0364
FS48360X29202	15	60.0	.035	70.0	.0328	80.0	.026	85.0	.0203		
FS48360X29001	16		5 10	72.0	180.0	12	4.601	20.0	0.0	20.0	
FS48360X29201	16	72.0	.0301	90.0	.0316	108.0	.0324	126.0	.0337	144.0	.0358
FS48360X29202	16	153.0	.0372	162.0	.0393	169.2	.0397	172.8	.0406	176.4	.042
FS48360X29203	16	178.2	.0456	180.0	.0527						
FS48360X29001	17		4 10	0.0	85.0	18	4.601	40.0	0.0		180.0
FS48360X29201	17	0.0	.0403	10.0	.0455	20.0	.0562	25.0	.0617	30.0	.0679
FS48360X29202	17	34.0	.0736	36.0	.079	38.0	.0884	40.0	.0979	42.0	.0889
FS48360X29203	17	44.0	.0855	46.0	.0857	50.0	.0893	55.0	.0933	60.0	.0955
FS48360X29204	17	70.0	.1078	80.0	.1124	85.0	.1079				
FS48360X29001	18		4 10	10.0	85.0	8	4.601	40.0	0.0		0.0
FS48360X29201	18	10.0	.0382	20.0	.0369	30.0	.0393	50.0	.0323	60.0	.0313
FS48360X29202	18	70.0	.0268	80.0	.0264	85.0	.0332				
FS48360X29001	19		4 10	15.0	85.0	9	4.601	40.0	0.0		90.0
FS48360X29201	19	15.0	.0409	20.0	.0403	30.0	.0418	40.0	.0437	50.0	.0443
FS48360X29202	19	60.0	.0419	70.0	.0395	80.0	.0361	85.0	.0304		
FS48360X29001	20		5 10	46.8	180.0	14	4.601	40.0	0.0	40.0	
FS48360X29201	20	46.8	.0161	54.0	.0359	72.0	.0384	90.0	.0422	108.0	.0481
FS48360X29202	20	126.0	.0551	144.0	.0645	153.0	.0705	162.0	.0736	169.2	.0824
FS48360X29203	20	172.8	.0862	176.4	.0881	178.2	.0913	180.0	.0972		
FS48360X29001	21		4 10	0.0	85.0	18	4.601	60.0	0.0		180.0
FS48360X29201	21	0.0	.0358	10.0	.042	20.0	.0531	30.0	.0682	40.0	.0906
FS48360X29202	21	45.0	.1076	50.0	.1275	54.0	.1546	56.0	.1737	58.0	.2035
FS48360X29203	21	60.0	.2186	62.0	.2187	64.0	.2393	66.0	.2488	70.0	.2915
FS48360X29204	21	75.0	.3496	80.0	.47	85.0	.5678				
FS48360X29001	22		4 10	10.0	85.0	8	4.601	60.0	0.0		0.0
FS48360X29201	22	10.0	.0308	20.0	.0291	30.0	.0299	40.0	.0294	50.0	.0322
FS48360X29202	22	70.0	.0292	80.0	.0255	85.0	.0212				
FS48360X29001	23		4 10	20.0	85.0	8	4.601	60.0	0.0		90.0
FS48360X29201	23	20.0	.035	30.0	.0388	40.0	.0381	50.0	.0431	60.0	.0414
FS48360X29202	23	70.0	.0367	80.0	.0255	85.0	.017				
FS48360X29001	24		5 10	46.8	180.0	14	4.601	60.0	0.0	60.0	
FS48360X29201	24	46.8	.0222	54.0	.0303	72.0	.0325	90.0	.0377	108.0	.0443
FS48360X29202	24	126.0	.0598	144.0	.0842	153.0	.1012	162.0	.1241	169.2	.1492
FS48360X29203	24	172.8	.1669	176.4	.1979	178.2	.2142	180.0	.2194		
FS48360X29001	25		4 10	0.0	85.0	14	10.000	20.0	0.0		180.0
FS48360X29201	25	0.0	.0109	5.0	.0119	10.0	.0136	15.0	.0154	20.0	.0175
FS48360X29202	25	25.0	.016	30.0	.014	35.0	.0126	40.0	.013	50.0	.0115
FS48360X29203	25	60.0	.0114	70.0	.0122	80.0	.0085	85.0	.0155		
FS48360X29001	26		4 10	10.0	85.0	8	10.000	20.0	0.0		0.0
FS48360X29201	26	10.0	.0096	30.0	.0068	40.0	.0071	50.0	.0052	60.0	.0059

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TABLE D-6. (CONTINUED)

FS48360X29202	26	70.0	.0059	80.0	.0109	85.0	.0134				
FS48360X29001	27		4 10	10.0	85.0	9	10.000	20.0	0.0		90.0
FS48360X29201	27	10.0	.011	20.0	.0095	30.0	.0093	40.0	.008	50.0	.0063
FS48360X29202	27	60.0	.005	70.0	.0068	80.0	.0071	85.0	.0035		
FS48360X29001	28		5 10	54.0	180.0	11	10.000	20.0	0.0	20.0	
FS48360X29201	28	54.0	.0093	72.0	.0089	90.0	.0084	108.0	.011	126.0	.0123
FS48360X29202	28	144.0	.0141	153.0	.0149	162.0	.0193	169.2	.0176	176.4	.0177
FS48360X29203	28	180.0	.0177								
FS48360X29001	29		4 10	0.0	85.0	16	10.000	40.0	0.0		180.0
FS48360X29201	29	0.0	.0095	10.0	.0102	20.0	.0144	25.0	.0189	30.0	.0256
FS48360X29202	29	35.0	.0354	38.0	.0425	40.0	.0436	42.0	.0434	45.0	.0371
FS48360X29203	29	50.0	.0349	55.0	.0336	60.0	.0329	70.0	.0365	80.0	.0338
FS48360X29204	29	85.0	.0414								
FS48360X29001	30		4 10	10.0	85.0	8	10.000	40.0	0.0		0.0
FS48360X29201	30	10.0	.0078	20.0	.0078	30.0	.0074	50.0	.0046	60.0	.0053
FS48360X29202	30	70.0	.0062	80.0	.0056	85.0	.0086				
FS48360X29001	31		4 10	15.0	85.0	9	10.000	40.0	0.0		90.0
FS48360X29201	31	15.0	.0085	20.0	.0077	30.0	.0071	40.0	.0077	50.0	.0049
FS48360X29202	31	60.0	.0035	70.0	.004	80.0	.0035	85.0	.0017		
FS48360X29001	32		5 10	46.8	180.0	14	10.000	40.0	0.0	40.0	
FS48360X29201	32	46.8	.0051	54.0	.006	72.0	.0062	90.0	.007	108.0	.0087
FS48360X29202	32	126.0	.0113	144.0	.0139	154.8	.0171	162.0	.0176	165.6	.0202
FS48360X29203	32	169.2	.0269	172.8	.0345	176.4	.0375	180.0	.0431		
FS48360X29001	33		4 10	0.0	85.0	23	10.000	60.0	0.0		180.0
FS48360X29201	33	0.0	.0062	10.0	.0096	20.0	.0169	30.0	.0196	35.0	.0242
FS48360X29202	33	40.0	.0289	45.0	.0645	50.0	.1448	52.0	.2059	54.0	.3105
FS48360X29203	33	56.0	.4879	57.0	.5729	58.0	.6375	59.0	.6622	60.0	.6517
FS48360X29204	33	61.0	.5894	64.0	.5057	66.0	.4589	68.0	.4367	70.0	.4514
FS48360X29205	33	75.0	.4932	80.0	.5441	85.0	.3173				
FS48360X29001	34		4 10	10.0	85.0	8	10.000	60.0	0.0		0.0
FS48360X29201	34	10.0	.006	20.0	.0047	30.0	.0057	40.0	.0036	50.0	.0061
FS48360X29202	34	70.0	.0104	80.0	.0119	85.0	.0132				
FS48360X29001	35		4 10	20.0	85.0	8	10.000	60.0	0.0		90.0
FS48360X29201	35	20.0	.0075	30.0	.0057	40.0	.0054	50.0	.0052	60.0	.0046
FS48360X29202	35	70.0	.0054	80.0	.006	85.0	.0053				
FS48360X29001	36		5 10	54.0	180.0	19	10.000	60.0	0.0	60.0	
FS48360X29201	36	54.0	.0041	72.0	.0062	90.0	.0048	108.0	.0041	126.0	.0129
FS48360X29202	36	144.0	.0212	154.8	.0327	162.0	.0546	165.6	.0636	169.2	.094
FS48360X29203	36	172.8	.1484	174.6	.2028	175.7	.2507	176.4	.2857	177.1	.3585
FS48360X29204	36	177.8	.4175	178.6	.5051	179.3	.5871	180.0	.6434		

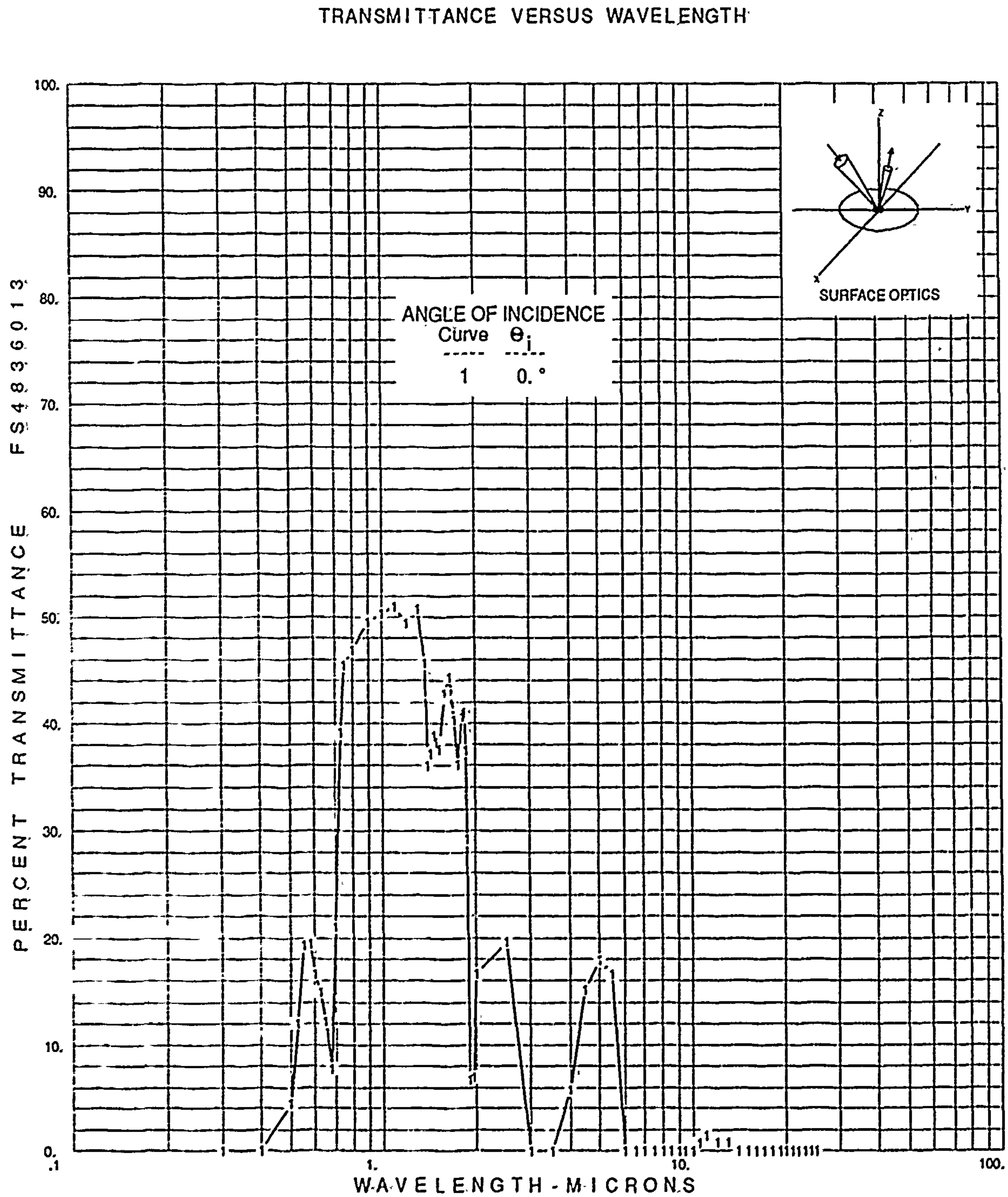

FIGURE D-22. SPECTRAL SCIENCES: LEAF SAMPLE, BOTTOM SIDE
SCATTERED TRANSMITTANCE VS. WAVELENGTH
BANDWIDTH: 0.3 TO 25.0 MICROMETERS

APPENDIX D

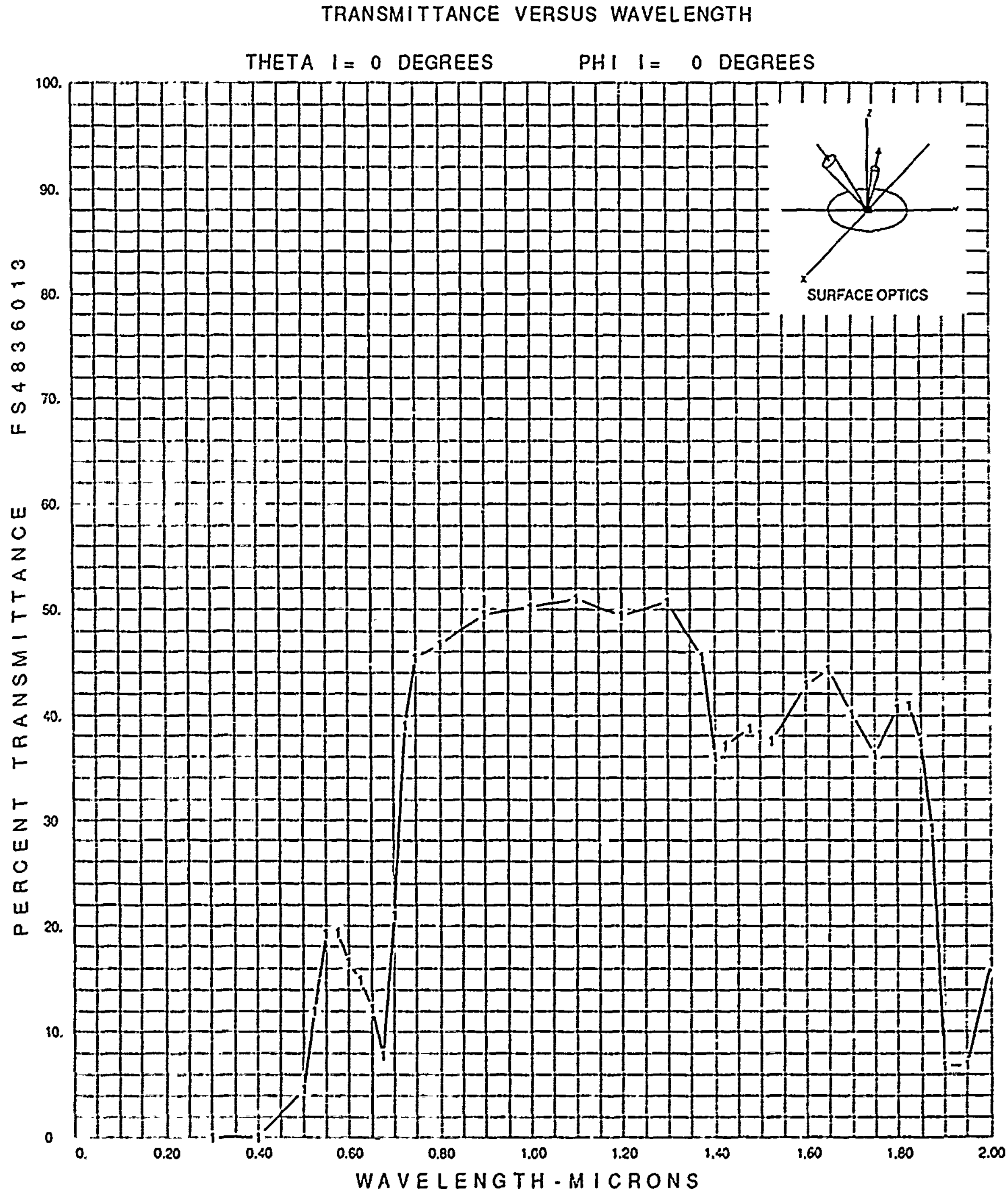

FIGURE D-23. SPECTRAL SCIENCES: LEAF SAMPLE, BOTTOM SIDE
SCATTERED TRANSMITTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 2.0 MICROMETERS

APPENDIX D

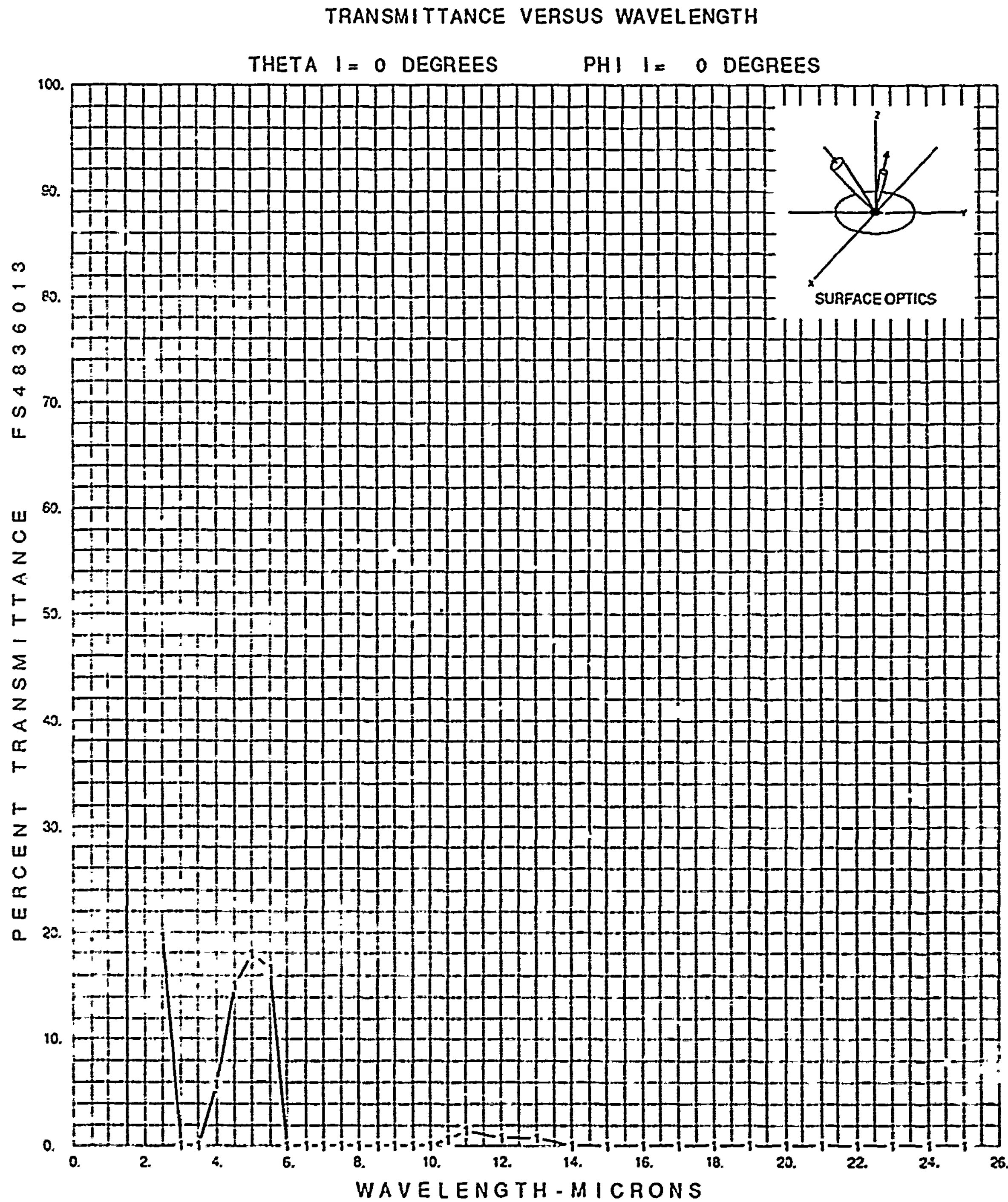

FIGURE D-24. SPECTRAL SCIENCES: LEAF SAMPLE, BOTTOM SIDE
SCATTERED TRANSMITTANCE VS. WAVELENGTH
BANDWIDTH 2.5 TO 25.0 MICROMETERS

APPENDIX D

TABLE D-7. SPECTRAL SCIENCES: LEAF SAMPLE, BOTTOM SIDE SCATTERED TRANSMITTANCE VS. WAVELENGTH - ERAS DATA DATA FROM 0.3 TO 2.0 MICROMETERS MEASURED ON A FRESH, MOIST LEAF

FS48360135001		1	31								
FS48360135101		SPECTRAL SCIENCES: LEAF SAMPLE, BOTTOM SIDE									
FS48360135102		SCATTERED TRANSMITTANCE									
FS48360137001		092790									
FS48360139001	1	001	31	.3	25.	68				0.	0.
FS48360139201	1	.3	0.0	.4	0.0	.5	4.5	.525	12.0	.55	19.2
FS48360139202	1	.575	19.3	.6	16.6	.625	14.9	.65	12.2	.675	7.7
FS48360139203	1	.7	21.0	.725	39.1	.75	45.4	.8	46.8	.9	49.5
FS48360139204	1	1.	50.3	1.1	51.0	1.2	49.4	1.3	50.7	1.375	45.6
FS48360139205	1	1.4	36.0	1.425	37.1	1.475	38.8	1.5	38.2	1.525	37.5
FS48360139206	1	1.6	42.8	1.65	44.3	1.7	40.2	1.75	36.2	1.8	40.6
FS48360139207	1	1.825	41.0	1.85	37.4	1.875	29.2	1.9	6.7	1.95	6.9
FS48360139208	1	2.	16.6	2.5	19.6	3.	0.0	3.5	0.0	4.	5.8
FS48360139209	1	4.5	15.1	5.	17.9	5.5	16.6	6.	0.0	6.5	0.0
FS48360139210	1	7.	0.0	7.5	0.0	8.	0.0	8.5	0.0	9.	0.0
FS48360139211	1	9.5	0.0	10.	0.0	10.5	0.7	11.	1.5	12.	0.8
FS48360139212	1	13.	0.8	14.	0.0	15.	0.0	16.	0.0	17.	0.0
FS48360139213	1	18.	0.0	19.	0.0	20.	0.0	21.	0.0	22.	0.0
FS48360139214	1	23.	0.0	24.	0.0	25.	0.0				

APPENDIX D

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APPENDIX E

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GREEN ASPEN LEAF,
BOTTOM OF LEAF A
FS4866:

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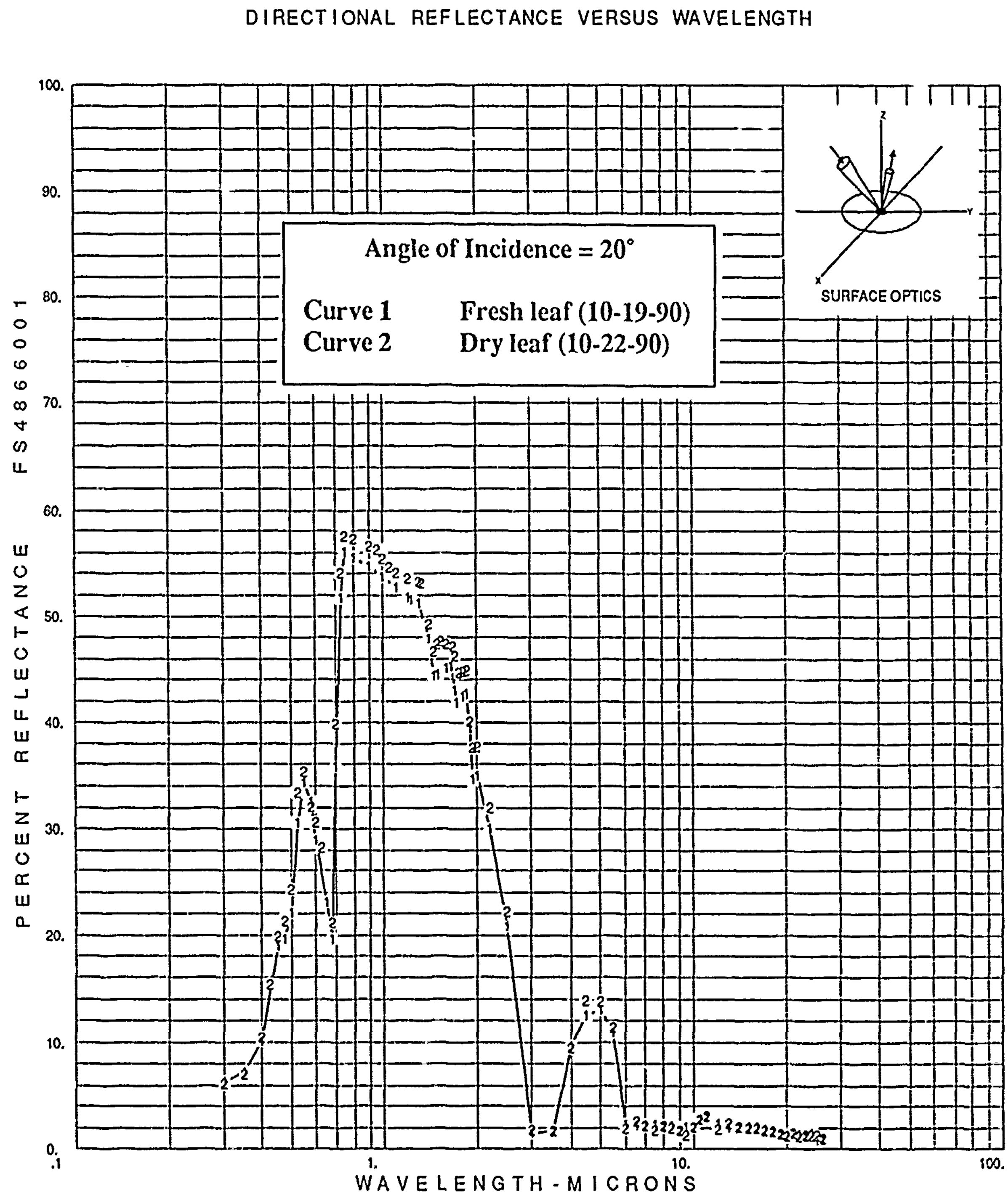

FIGURE E-1. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
BOTTOM OF LEAF A
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 26.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX E

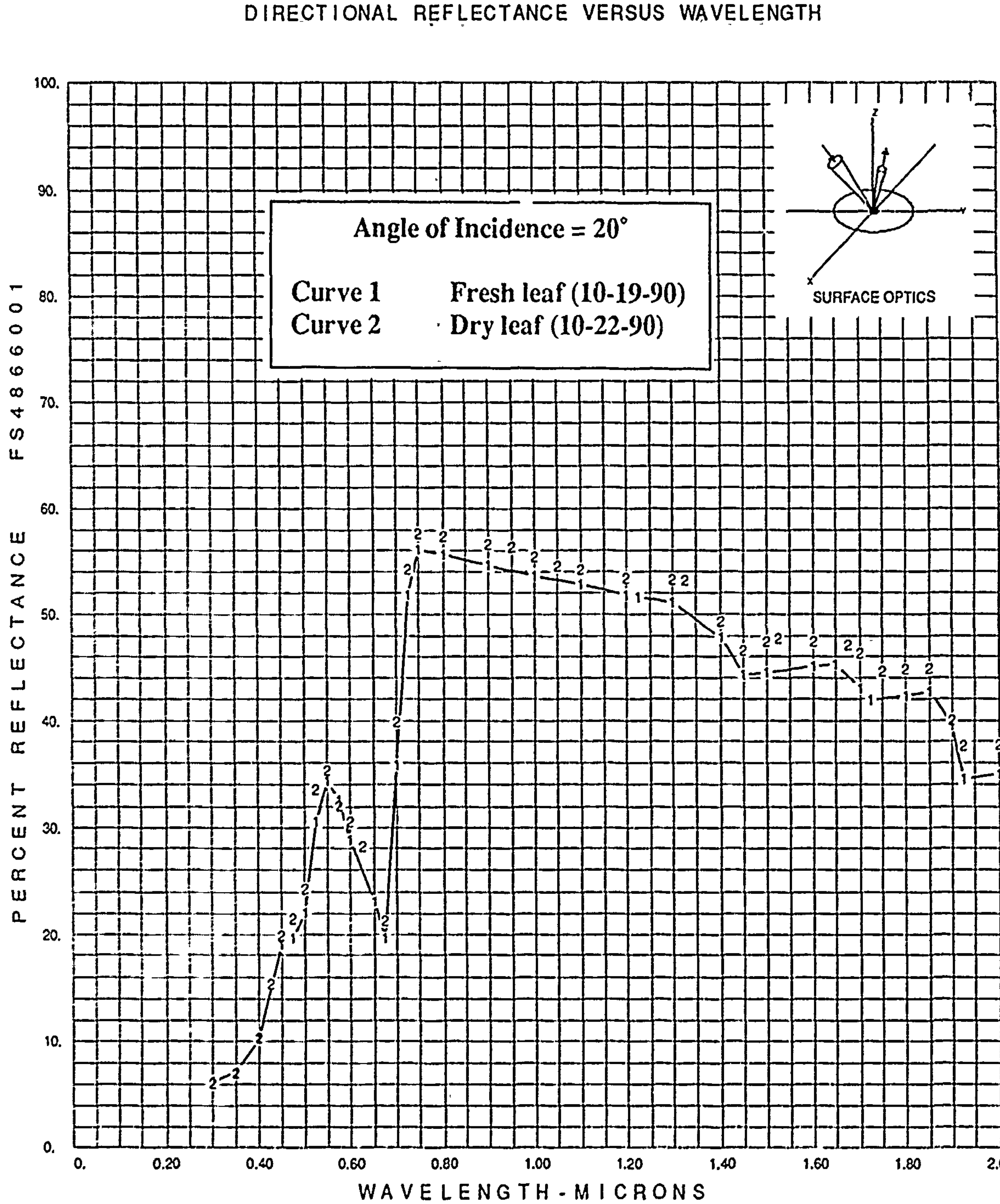

FIGURE E-2. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
BOTTOM OF LEAF A
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 2.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX E

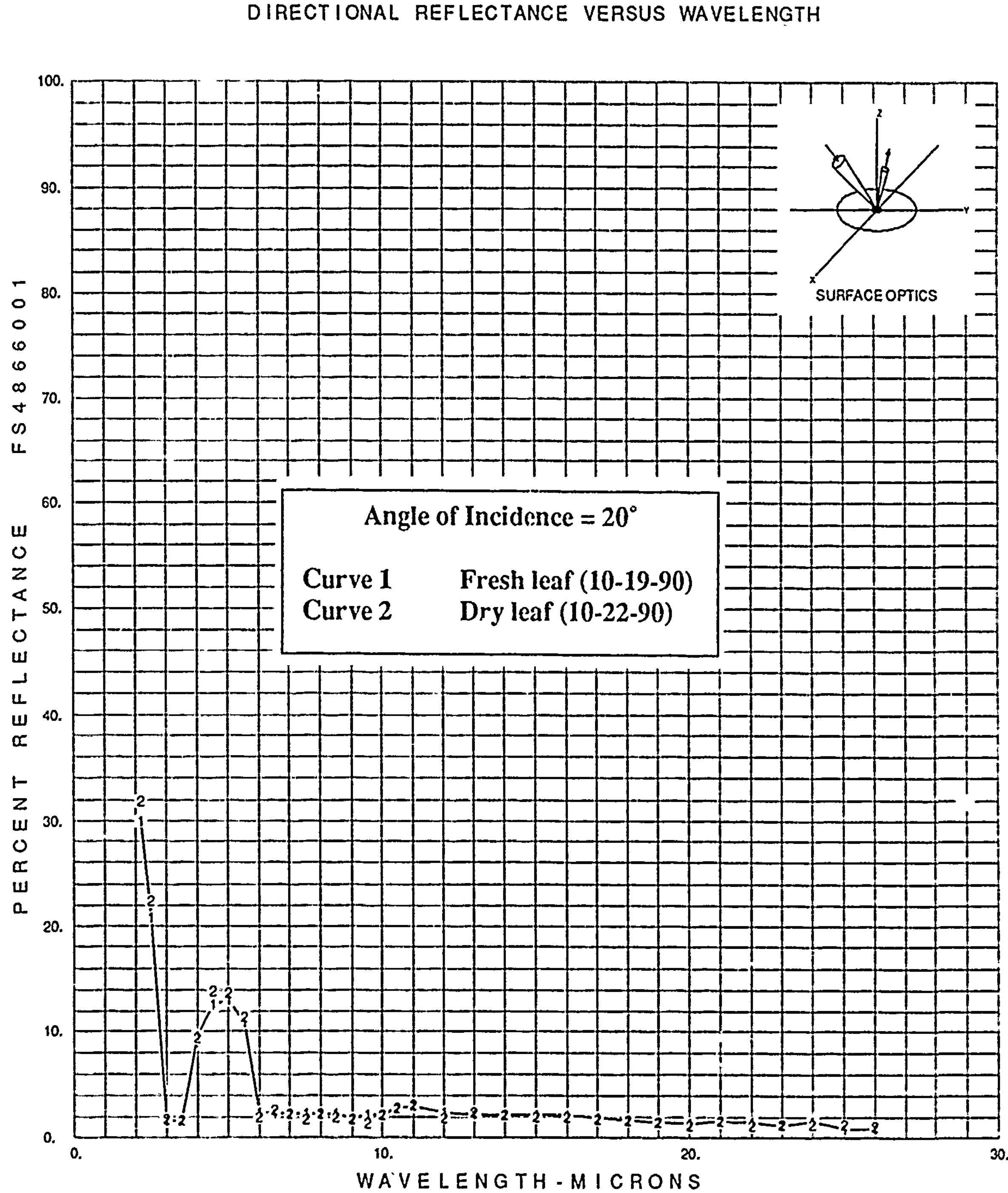

FIGURE E-3. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
BOTTOM OF LEAF A
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 2.2 TO 26.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

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TABLE E-1. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
BOTTOM OF LEAF A
DIRECTIONAL REFLECTANCE VS. WAVELENGTH - ERAS DATA
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION
CURVE 1 - FRESH LEAF, CURVE 2 - DRY LEAF

FS48660015001		2	1								
FS48660015101		SPECTRAL SCIENCES: GREEN ASPEN LEAF. BOTTOM OF LEAF A									
FS48660015102		Curve 1 measured 10-19-90, Curve 2 measured 10-22-90									
FS48660015103		UNCORRECTED FOR INSTRUMENTATION POLARIZATION EFFECTS									
FS48660017001		101990 and 102290									
FS48660019001	1	001	1	.3	26.	68				20.	0.
FS48660019201	1	.3	6.3	.35	7.2	.4	10.2	.45	19.0	.475	19.7
FS48660019202	1	.5	22.1	.525	30.5	.55	34.4	.575	32.5	.6	28.9
FS48660019203	1	.65	23.1	.675	19.7	.7	35.8	.725	51.8	.75	56.1
FS48660019204	1	.8	55.6	.9	54.7	1.	53.7	1.1	52.8	1.2	51.8
FS48660019205	1	1.225	51.6	1.3	51.2	1.4	47.9	1.45	44.4	1.5	44.6
FS48660019206	1	1.6	45.1	1.65	45.3	1.7	43.0	1.725	41.9	1.8	42.4
FS48660019207	1	1.85	42.7	1.9	39.5	1.925	34.6	2.	35.0	2.2	30.0
FS48660019208	1	2.5	20.8	3.	1.6	3.5	1.7	4.	9.6	4.5	12.6
FS48660019209	1	5.	13.0	5.5	10.9	6.	2.4	6.5	2.3	7.	2.3
FS48660019210	1	7.5	2.3	8.	2.1	8.5	2.2	9.	1.8	9.5	2.1
FS48660019211	1	10.	2.1	10.5	2.8	11.	3.0	12.	2.4	13.	2.1
FS48660019212	1	14.	2.1	15.	2.1	16.	2.1	17.	1.9	18.	1.7
FS48660019213	1	19.	1.5	20.	1.4	21.	1.6	22.	1.5	23.	1.2
FS48660019214	1	24.	1.6	25.	0.9	26.	0.9				
FS48660019001	2	001	1	.3	26.	72				20.	0.
FS48660019201	2	.3	6.1	.35	7.1	.4	10.4	.425	15.4	.45	19.9
FS48660019202	2	.475	21.4	.5	24.3	.525	33.5	.55	35.4	.575	32.1
FS48660019203	2	.6	30.5	.625	28.2	.675	21.2	.7	39.9	.725	54.2
FS48660019204	2	.75	57.6	.8	57.3	.9	56.6	.95	56.3	1.	55.4
FS48660019205	2	1.05	54.6	1.1	54.2	1.2	53.5	1.3	53.3	1.325	53.2
FS48660019206	2	1.4	49.3	1.45	46.7	1.5	47.4	1.525	47.7	1.6	47.4
FS48660019207	2	1.675	47.1	1.7	46.3	1.75	44.7	1.8	44.8	1.85	44.9
FS48660019208	2	1.9	40.1	1.925	37.7	2.	37.8	2.2	31.9	2.5	22.3
FS48660019209	2	3.	1.8	3.5	1.7	4.	9.4	4.5	13.9	5.	13.7
FS48660019210	2	5.5	11.4	6.	2.0	6.5	2.6	7.	2.2	7.5	1.8
FS48660019211	2	8.	2.2	8.5	2.0	9.	1.8	9.5	1.4	10.	2.1
FS48660019212	2	10.5	2.8	11.	3.1	12.	1.9	13.	2.4	14.	2.1
FS48660019213	2	15.	2.0	16.	2.0	17.	1.8	18.	1.7	19.	1.5
FS48660019214	2	20.	1.2	21.	1.6	22.	1.2	23.	1.3	24.	1.3
FS48660019215	2	25.	1.3	26.	1.0						

APPENDIX F

SPECTRAL SCIENCES INC.
GREEN ASPEN LEAF,
TOP OF LEAF A
FS4867:

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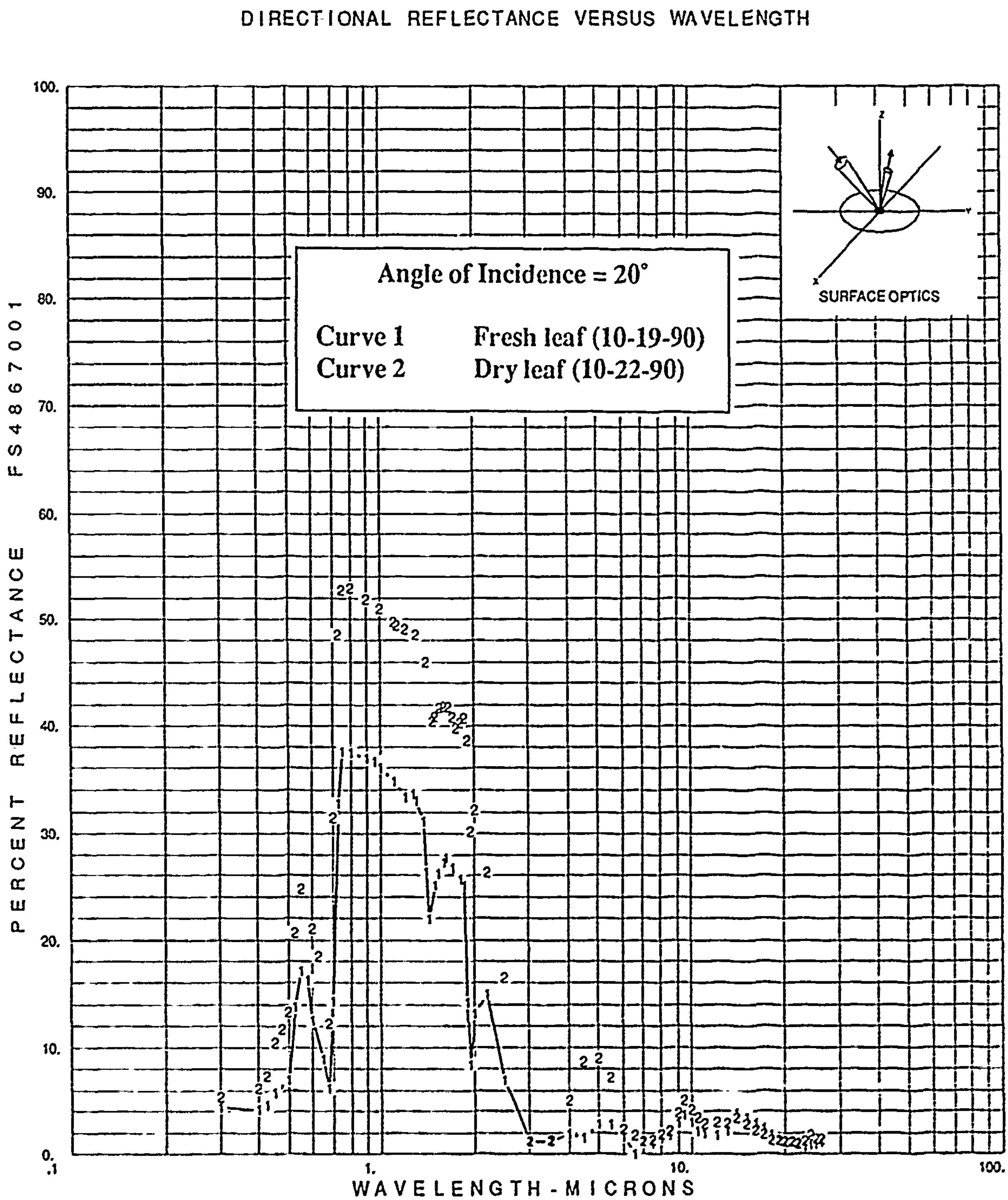

FIGURE F-1. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
TOP OF LEAF A
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 26.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX F

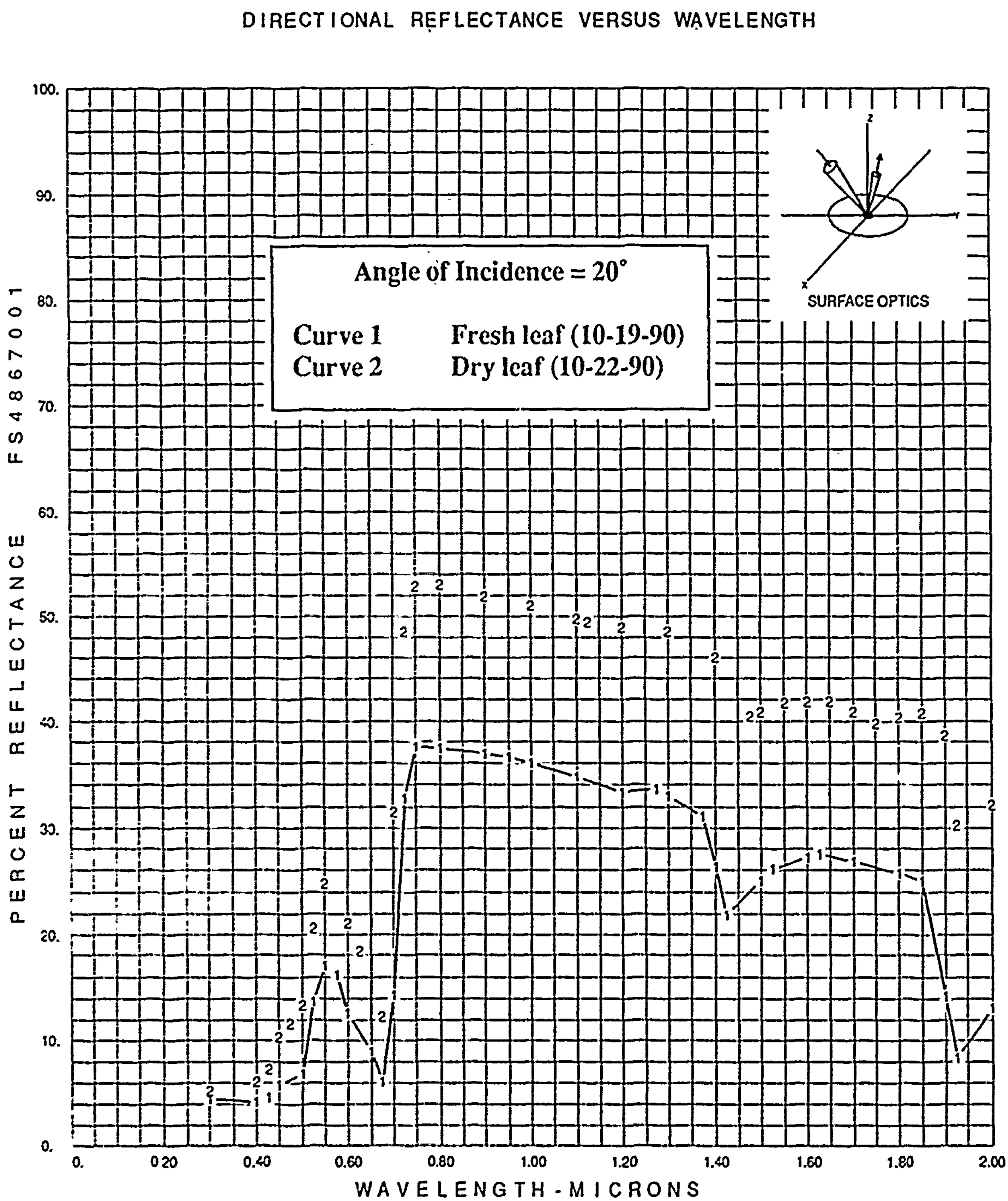

FIGURE F-2. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
TOP OF LEAF A
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 2.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX F

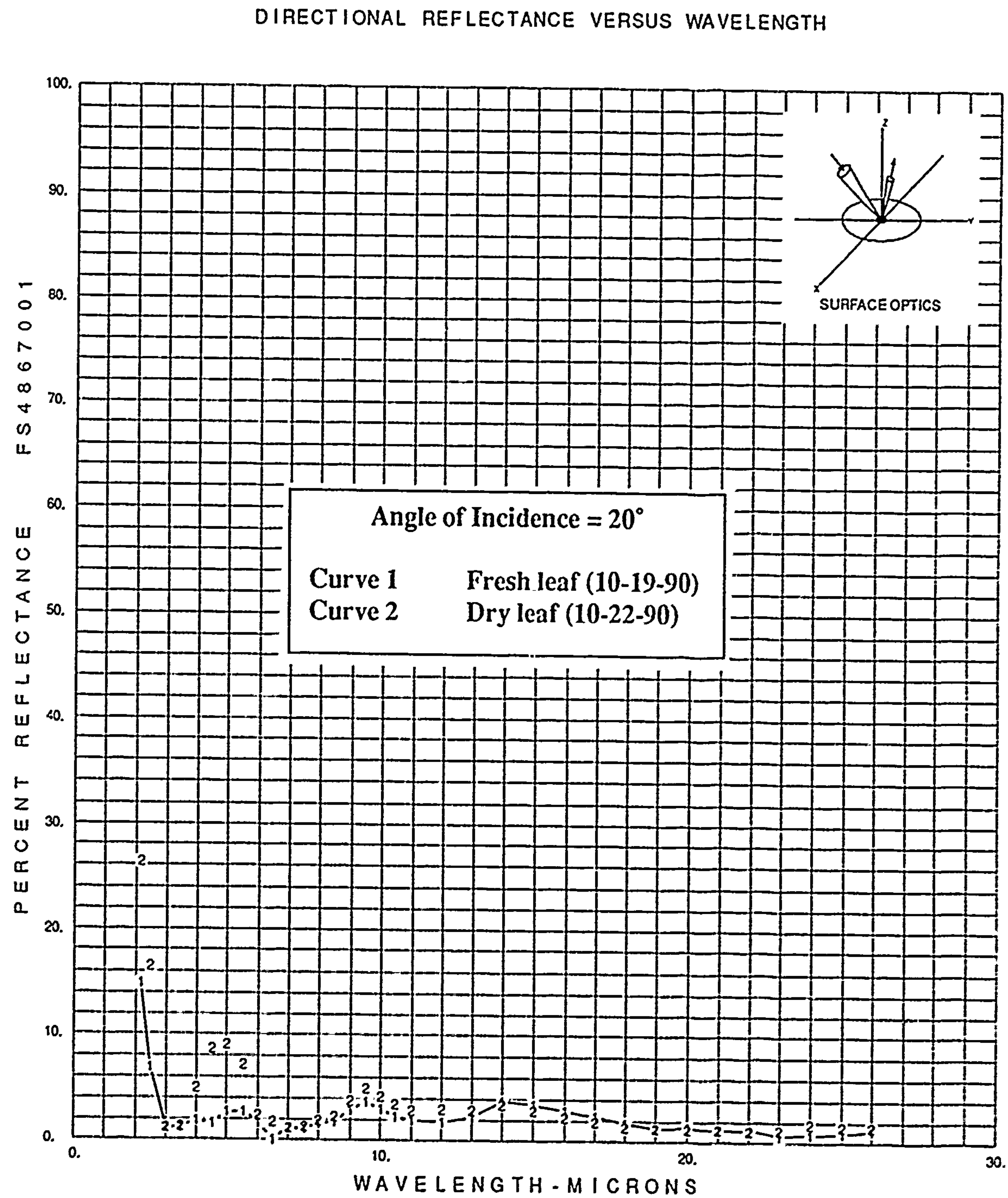

FIGURE F-3. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
TOP OF LEAF A
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 2.2 TO 26.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

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TABLE F-1. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
TOP OF LEAF A
DIRECTIONAL REFLECTANCE VS. WAVELENGTH - ERAS DATA
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION
CURVE 1 - FRESH LEAF, CURVE 2 - DRY LEAF

FS48670015001		2	1								
FS48670015101		SPECTRAL SCIENCES: GREEN ASPEN LEAF. TOP OF LEAF A									
FS48670015102		Curve 1 measured 10-19-90, Curve 2 measured 10-22-90									
FS48670015103		UNCORRECTED FOR INSTRUMENTATION POLARIZATION EFFECTS									
FS48670017001		101990 and 102290									
FS48670019001	1	001	1	.3	26.	69				20.	0.
FS48670019201	1	.3	4.4	.4	4.2	.425	4.6	.45	5.8	.5	6.9
FS48670019202	1	.525	13.7	.55	17.1	.575	16.2	.6	12.5	.65	8.9
FS48670019203	1	.675	6.1	.7	14.3	.725	32.7	.75	37.6	.8	37.4
FS48670019204	1	.9	36.9	.95	36.7	1.	36.0	1.1	34.7	1.2	33.4
FS48670019205	1	1.275	33.6	1.3	33.0	1.375	31.1	1.4	26.4	1.425	21.9
FS48670019206	1	1.5	25.1	1.525	26.1	1.6	27.2	1.625	27.6	1.7	26.8
FS48670019207	1	1.8	25.7	1.85	25.1	1.9	14.2	1.925	8.4	2.	13.1
FS48670019208	1	2.2	14.9	2.5	6.9	3.	1.2	3.5	1.2	4.	1.9
FS48670019209	1	4.5	1.6	5.	2.7	5.5	2.7	6.	1.7	6.5	0.0
FS48670019210	1	7.	1.2	7.5	1.0	8.	1.6	8.5	1.8	9.	2.9
FS48670019211	1	9.5	3.7	10.	3.0	10.5	2.2	11.	2.0	12.	1.8
FS48670019212	1	13.	2.2	14.	3.8	15.	3.5	16.	2.9	17.	2.4
FS48670019213	1	18.	1.8	19.	1.3	20.	1.4	21.	1.2	22.	1.1
FS48670019214	1	23.	0.7	24.	0.8	25.	0.9	26.	1.1		
FS48670019001	2	001	1	.3	26.	68				20.	0.
FS48670019201	2	.3	5.3	.4	6.1	.425	7.3	.45	10.4	.475	11.7
FS48670019202	2	.5	13.3	.525	20.6	.55	24.7	.6	21.1	.625	18.5
FS48670019203	2	.675	12.2	.7	31.4	.725	48.5	.75	52.8	.8	53.0
FS48670019204	2	.9	51.9	1.	51.0	1.1	49.7	1.125	49.4	1.2	49.0
FS48670019205	2	1.3	48.5	1.4	46.0	1.475	40.4	1.5	40.8	1.55	41.7
FS48670019206	2	1.6	41.8	1.65	41.8	1.7	40.8	1.75	39.8	1.8	40.3
FS48670019207	2	1.85	40.7	1.9	38.6	1.925	30.2	2.	32.2	2.2	26.4
FS48670019208	2	2.5	16.5	3.	1.2	3.5	1.3	4.	5.0	4.5	8.7
FS48670019209	2	5.	9.0	5.5	7.2	6.	2.4	6.5	1.8	7.	1.2
FS48670019210	2	7.5	1.3	8.	1.9	8.5	2.2	9.	3.8	9.5	5.0
FS48670019211	2	10.	4.2	10.5	3.5	11.	2.9	12.	3.0	13.	2.9
FS48670019212	2	14.	3.5	15.	2.9	16.	2.3	17.	1.9	18.	1.4
FS48670019213	2	19.	1.3	20.	1.2	21.	1.2	22.	1.0	23.	1.2
FS48670019214	2	24.	1.8	25.	1.5	26.	1.5				

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APPENDIX G

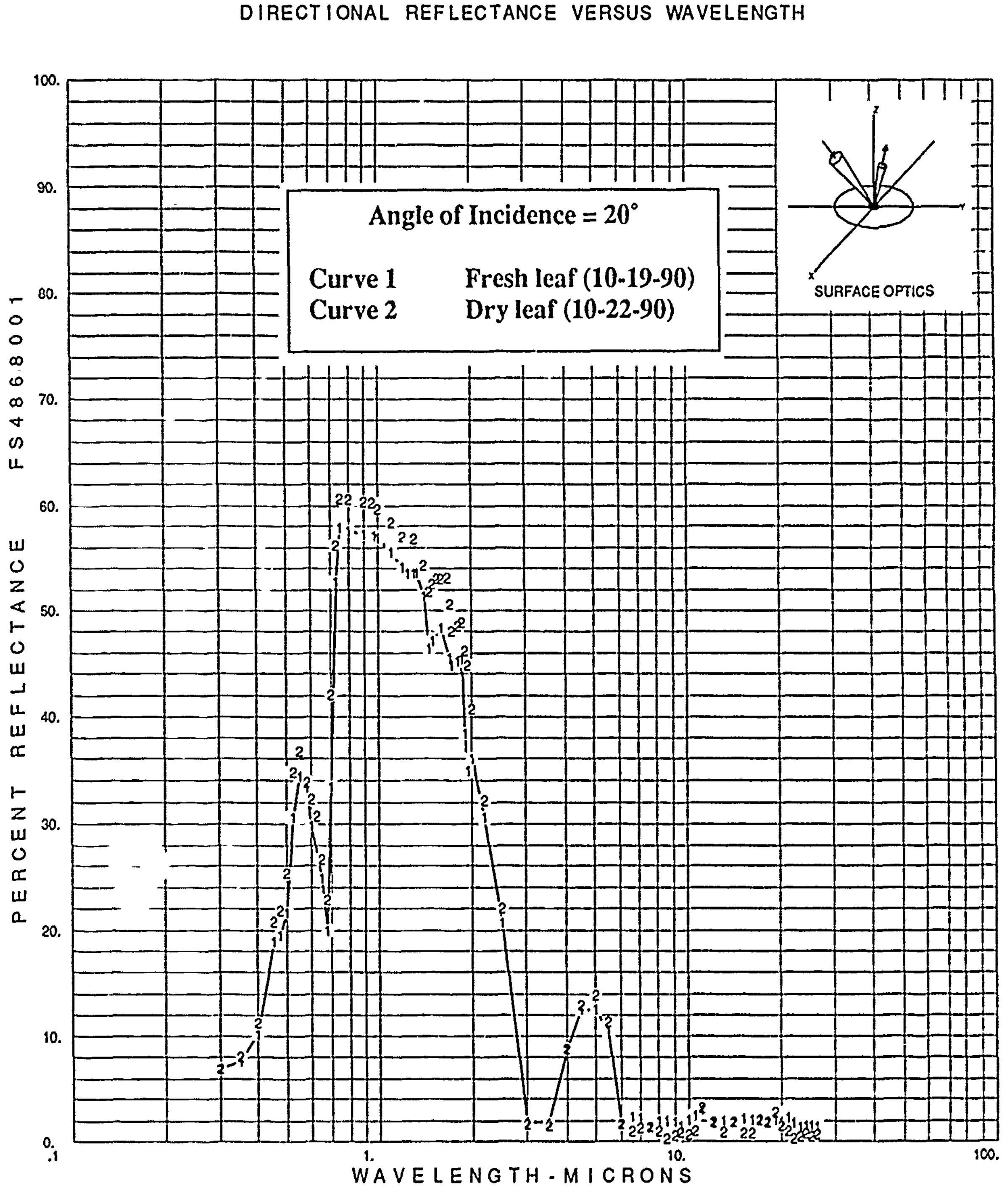

FIGURE G-1. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
BOTTOM OF LEAF B
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 26.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX G

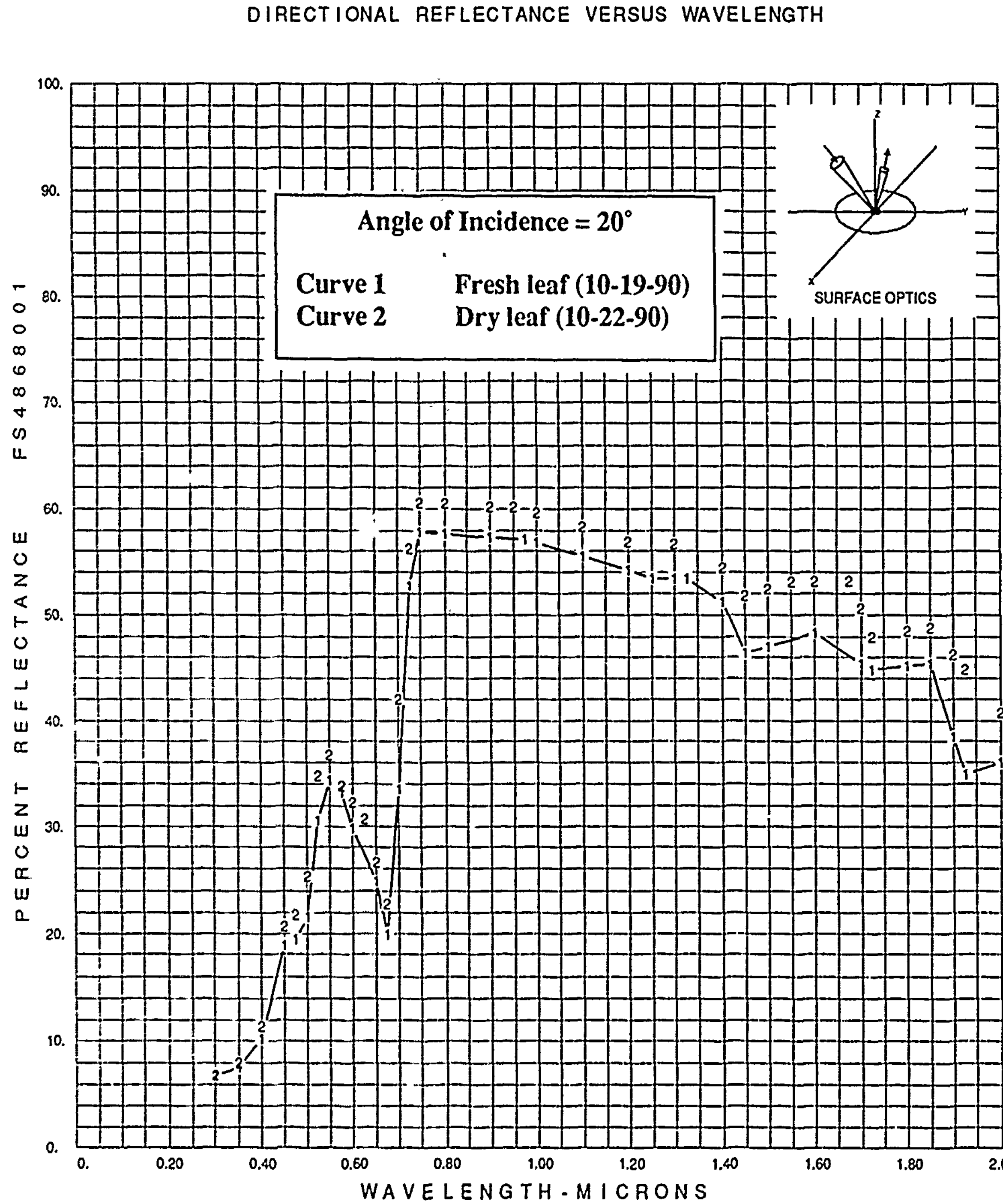

FIGURE G-2. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
BOTTOM OF LEAF B
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 2.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX G

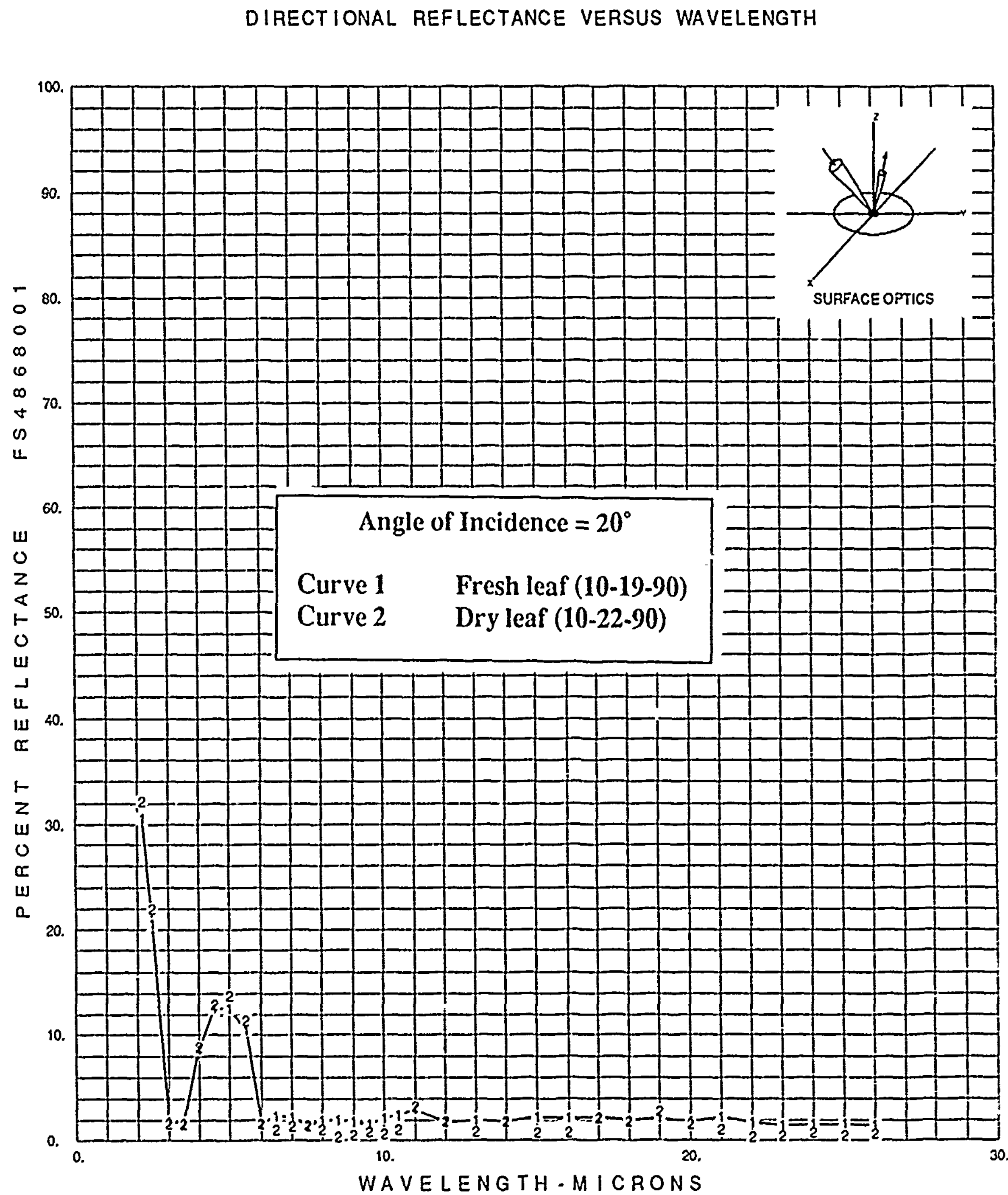

FIGURE G-3. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
BOTTOM OF LEAF B
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 2.2 TO 26.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX G

TABLE G-1. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
BOTTOM OF LEAF B
DIRECTIONAL REFLECTANCE VS. WAVELENGTH - ERAS DATA
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION
CURVE 1 - FRESH LEAF, CURVE 2 - DRY LEAF

FS48680015001		2	1								
FS48680015101		SPECTRAL SCIENCES: GREEN ASPEN LEAF. BOTTOM OF LEAF B									
FS48680015102		Curve 1 measured 10-19-90, Curve 2 measured 10-22-90									
FS48680015103		UNCORRECTED FOR INSTRUMENTATION POLARIZATION EFFECTS									
FS48680017001		101990 and 102290									
FS48680019001	1	001	1	.3	26.	69				20.	0.
FS48680019201	1	.3	6.9	.35	7.6	.4	10.2	.45	18.9	.475	19.5
FS48680019202	1	.5	21.6	.525	30.5	.55	34.4	.575	33.3	.6	29.8
FS48680019203	1	.65	24.8	.675	20.0	.7	33.5	.725	52.7	.75	57.8
FS48680019204	1	.8	57.6	.9	57.3	.975	57.1	1.	56.8	1.1	55.5
FS48680019205	1	1.2	54.2	1.25	53.5	1.3	53.5	1.325	53.5	1.4	51.3
FS48680019206	1	1.45	46.4	1.5	47.0	1.6	48.3	1.7	45.5	1.725	44.8
FS48680019207	1	1.8	45.2	1.85	45.4	1.9	38.4	1.925	34.9	2.	36.0
FS48680019208	1	2.2	30.5	2.5	20.6	3.	1.9	3.5	1.8	4.	8.7
FS48680019209	1	4.5	12.5	5.	12.5	5.5	10.5	6.	1.7	6.5	2.4
FS48680019210	1	7.	2.3	7.5	1.5	8.	2.0	8.5	2.0	9.	1.9
FS48680019211	1	9.5	1.6	10.	2.1	10.5	2.5	11.	3.0	12.	1.8
FS48680019212	1	13.	2.0	14.	1.9	15.	2.2	16.	2.1	17.	2.2
FS48680019213	1	18.	2.0	19.	2.1	20.	1.9	21.	2.3	22.	1.8
FS48680019214	1	23.	1.5	24.	1.6	25.	1.6	26.	1.5		
FS48680019001	2	001	1	.3	26.	70				20.	0.
FS48680019201	2	.3	6.9	.35	8.0	.4	11.3	.45	20.7	.475	21.8
FS48680019202	2	.5	25.4	.525	34.7	.55	36.8	.575	33.8	.6	32.3
FS48680019203	2	.625	30.7	.65	26.7	.675	22.8	.7	42.1	.725	56.2
FS48680019204	2	.75	60.6	.8	60.5	.9	60.3	.95	60.2	1.	59.6
FS48680019205	2	1.1	58.3	1.2	57.0	1.3	56.7	1.4	54.4	1.45	51.8
FS48680019206	2	1.5	52.5	1.55	53.1	1.6	53.1	1.675	53.2	1.7	50.6
FS48680019207	2	1.725	48.0	1.8	48.5	1.85	48.9	1.9	46.2	1.925	44.8
FS48680019208	2	2.	40.7	2.2	32.2	2.5	22.0	3.	1.7	3.5	1.6
FS48680019209	2	4.	8.8	4.5	12.9	5.	13.8	5.5	11.4	6.	1.7
FS48680019210	2	6.5	1.0	7.	1.4	7.5	1.5	8.	1.0	8.5	0.4
FS48680019211	2	9.	0.6	9.5	0.9	10.	0.7	10.5	1.0	11.	3.2
FS48680019212	2	12.	1.9	13.	0.9	14.	1.9	15.	0.8	16.	0.8
FS48680019213	2	17.	2.1	18.	1.9	19.	2.8	20.	1.6	21.	1.0
FS48680019214	2	22.	0.4	23.	0.5	24.	0.8	25.	0.5	26.	0.7

APPENDIX H

SPECTRAL SCIENCES INC.
GREEN ASPEN LEAF,
TOP OF LEAF C
FS4869:

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PAGE NO.

DIRECTIONAL REFLECTANCE

APPENDIX H

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APPENDIX H

DIRECTIONAL REFLECTANCE VERSUS WAVELENGTH

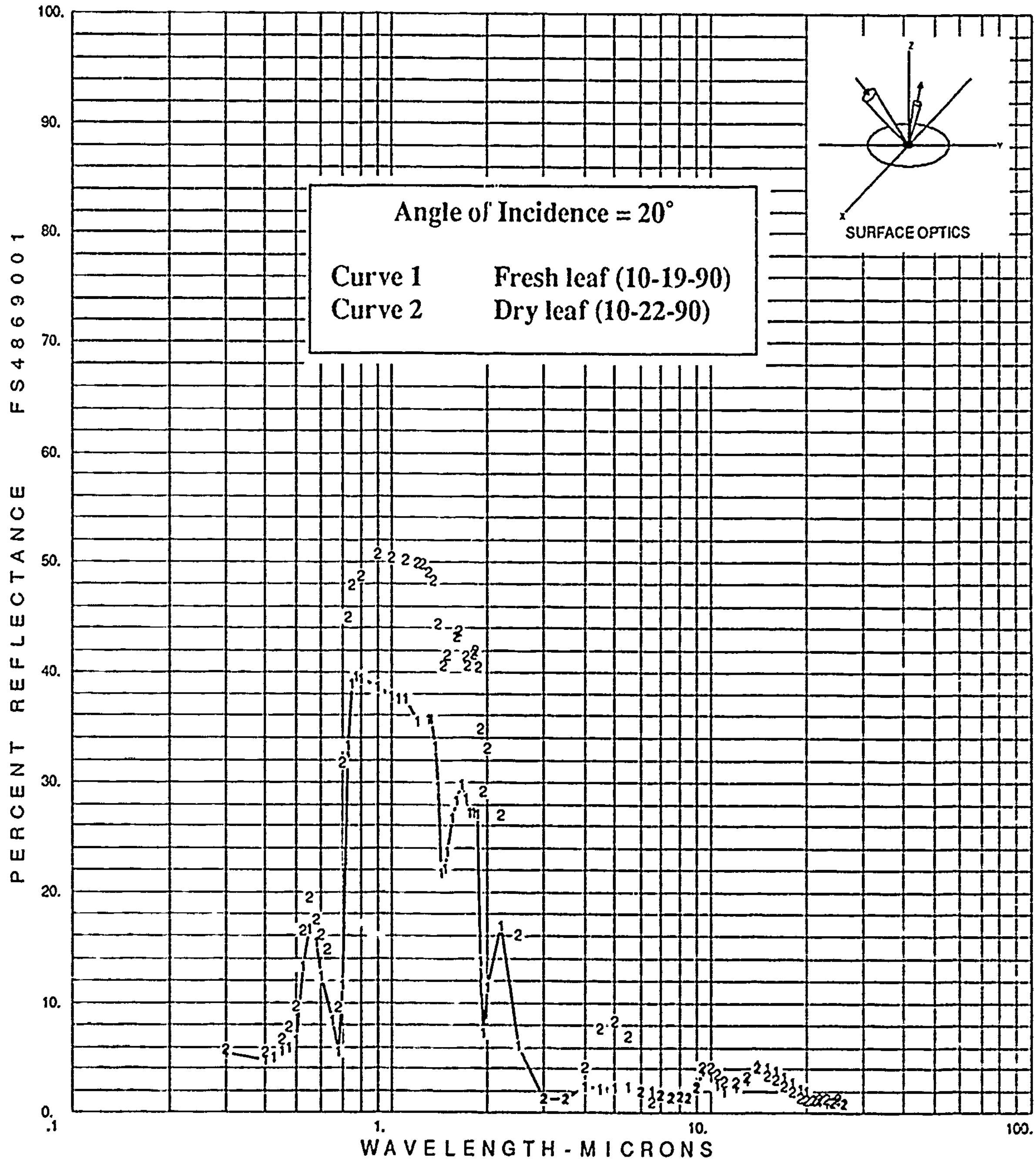

FIGURE H-1. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
TOP OF LEAF C
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 26.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX H

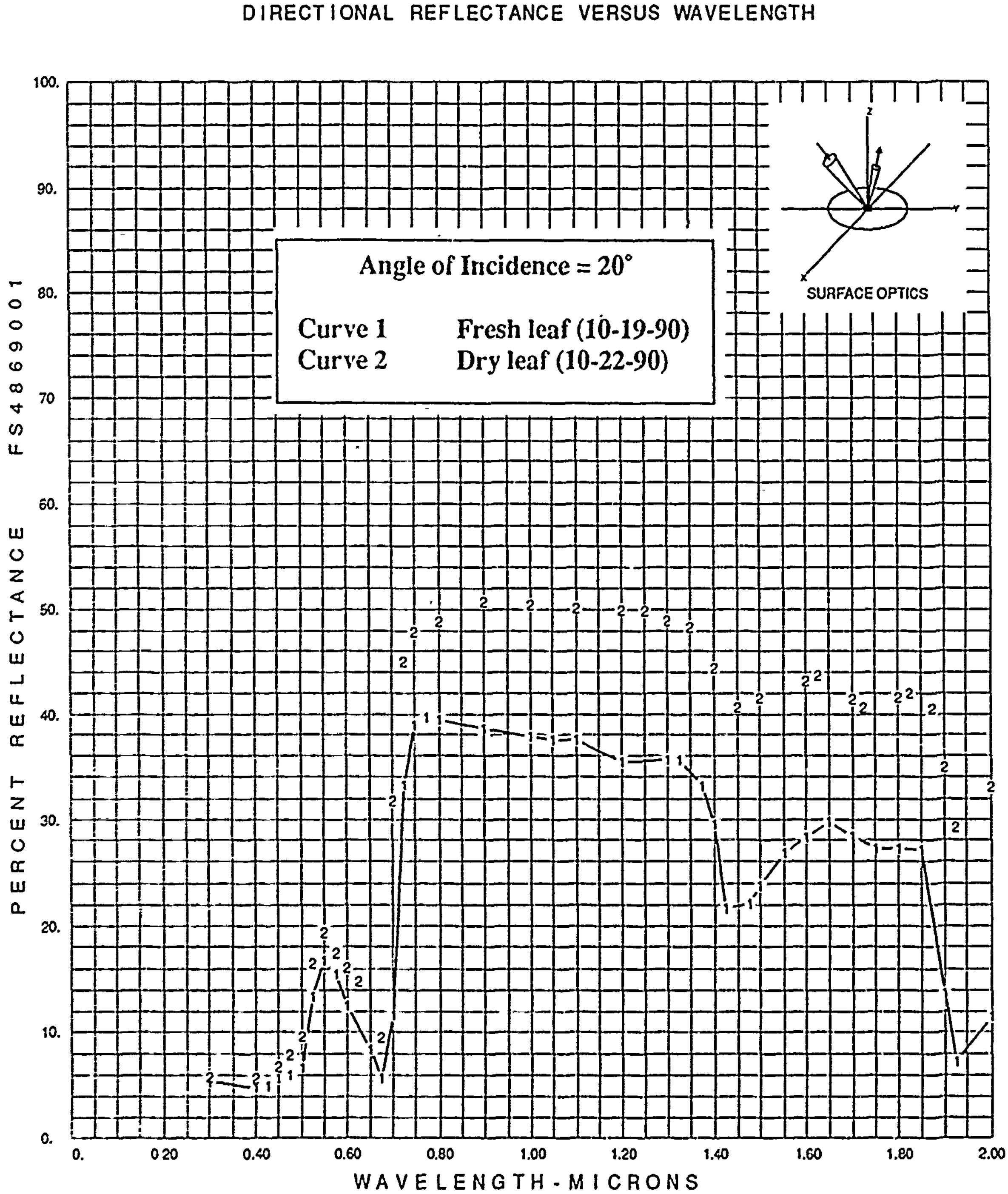

FIGURE H-2. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
TOP OF LEAF C
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 2.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX H

DIRECTIONAL REFLECTANCE VERSUS WAVELENGTH

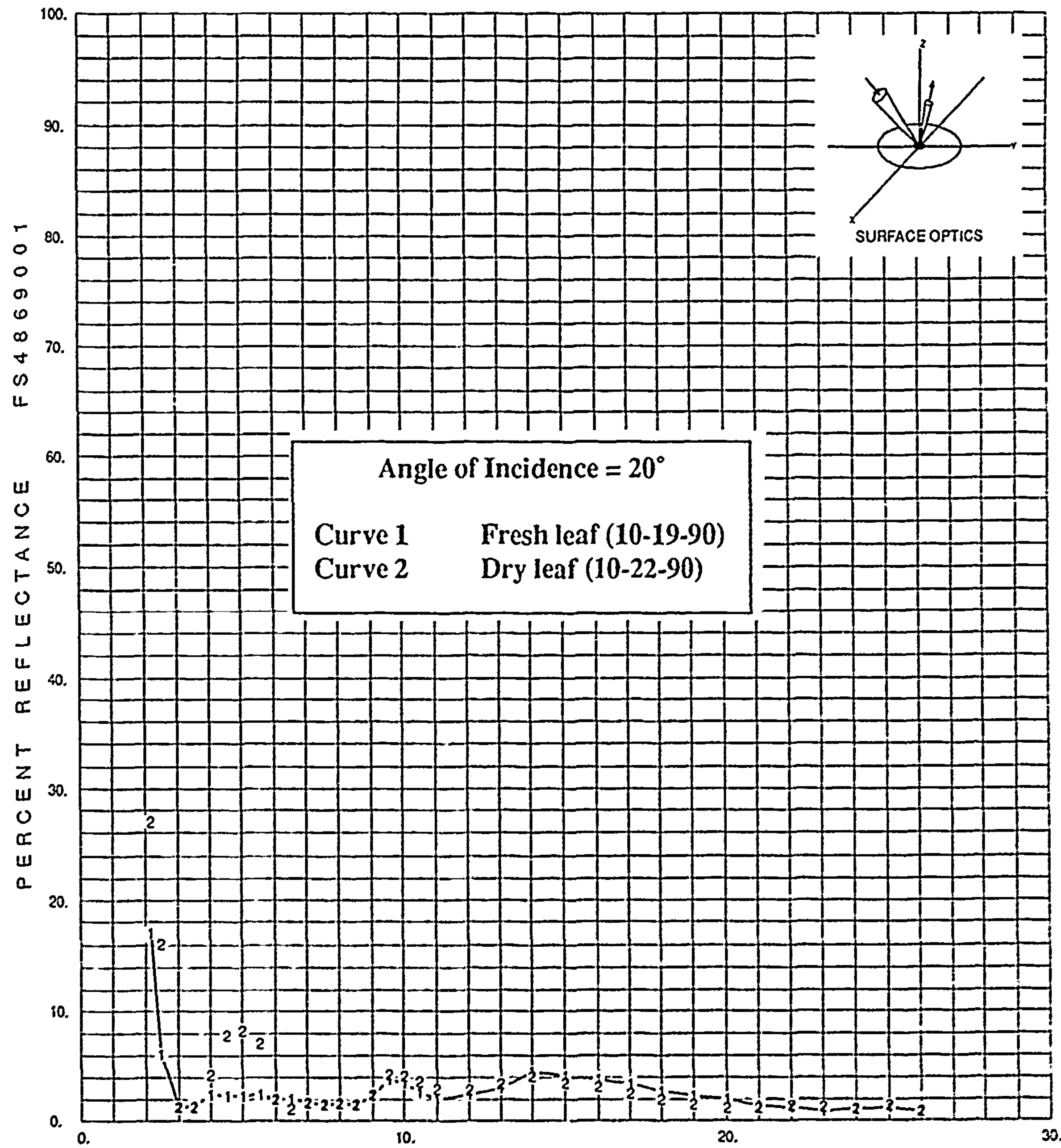

FIGURE H-3. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
TOP OF LEAF C
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 2.2 TO 26.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX H

TABLE H-1. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
TOP OF LEAF C
DIRECTIONAL REFLECTANCE VS. WAVELENGTH - ERAS DATA
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION
CURVE 1 - FRESH LEAF, CURVE 2 - DRY LEAF

```
FS48690015001        2      1
FS48690015101       SPECTRAL SCIENCES: GREEN ASPEN LEAF. TOP OF LEAF C
FS48690015102       Curve 1 measured 10-19-90, Curve 2 measured 10-22-90
FS48690015103       UNCORRECTED FOR INSTRUMENTATION POLARIZATION EFFECTS
FS48690017001       101990 and 102290
FS48690019001   1      001  1     .3    26.   73                        20.     0.
FS48690019201   1     .3   5.4    .4    4.8  .425   5.0   .45   5.7  .475    6.0
FS48690019202   1     .5   6.6  .525   13.3   .55  16.7  .575  15.5    .6   12.4
FS48690019203   1    .65   8.4  .675    5.6    .7  11.6  .725  33.3   .75   39.0
FS48690019204   1   .775  39.6    .8   39.4    .9  38.6    1.  37.9  1.05   37.5
FS48690019205   1    1.1  37.6   1.2   35.5   1.3  35.7 1.325  35.7 1.375   33.2
FS48690019206   1    1.4  29.6 1.425   21.7 1.475  22.1   1.5  23.7  1.55   26.8
FS48690019207   1    1.6  28.3  1.65   29.8   1.7  28.5  1.75  27.2   1.8   27.2
FS48690019208   1   1.85  27.1   1.9   13.7 1.925   7.3    2.  11.5   2.2   17.0
FS48690019209   1    2.5   6.1    3.    1.3   3.5   1.4    4.   2.4   4.5    2.2
FS48690019210   1     5.   2.3   5.5    2.4    6.   2.0   6.5   2.0    7.    1.7
FS48690019211   1    7.5   1.5    8.    1.6   8.5   1.5    9.   2.3   9.5    3.8
FS48690019212   1    10.   3.4  10.5    2.6   11.   2.0   12.   2.4   13.    3.0
FS48690019213   1    14.   4.4   15.    4.1   16.   3.8   17.   3.3   18.    2.7
FS48690019214   1    19.   2.2   20.    2.0   21.   1.4   22.   1.1   23.    0.9
FS48690019215   1    24.   1.0   25.    1.1   26.   0.9
FS48690019001   2      001  1     .3    26.   69                        20.     0.
FS48690019201   2     .3   5.8    .4    5.6   .45   6.7  .475   7.8    .5    9.6
FS48690019202   2   .525  16.5   .55   19.4  .575  17.5    .6  16.1  .625   14.8
FS48690019203   2   .675   9.5    .7   31.7  .725  45.0   .75  47.9    .8   48.8
FS48690019204   2     .9  50.7    1.   50.4   1.1  50.2   1.2  49.9  1.25   49.8
FS48690019205   2    1.3  49.0  1.35   48.3   1.4  44.5  1.45  40.6   1.5   41.5
FS48690019206   2    1.6  43.3 1.625   43.7   1.7  41.4 1.725  40.6   1.8   41.6
FS48690019207   2  1.825  42.0 1.875   40.5   1.9  34.9 1.925  29.2    2.   33.1
FS48690019208   2    2.2  27.0   2.5   16.1    3.   1.3   3.5   1.3    4.    4.2
FS48690019209   2    4.5   7.7    5.    8.3   5.5   7.1    6.   2.0   6.5    1.0
FS48690019210   2     7.   1.7   7.5    1.5    8.   1.6   8.5   1.5    9.    2.4
FS48690019211   2    9.5   4.2   10.    4.1  10.5   3.6   11.   2.9   12.    2.8
FS48690019212   2    13.   3.3   14.    4.1   15.   3.5   16.   3.1   17.    2.5
FS48690019213   2    18.   2.0   19.    1.5   20.   1.2   21.   1.2   22.    1.4
FS48690019214   2    23.   1.3   24.    1.0   25.   1.4   26.   0.9
```

APPENDIX I

SPECTRAL SCIENCES INC.
GREEN ASPEN LEAF,
BOTTOM OF LEAF C
FS4870:

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APPENDIX I

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APPENDIX I

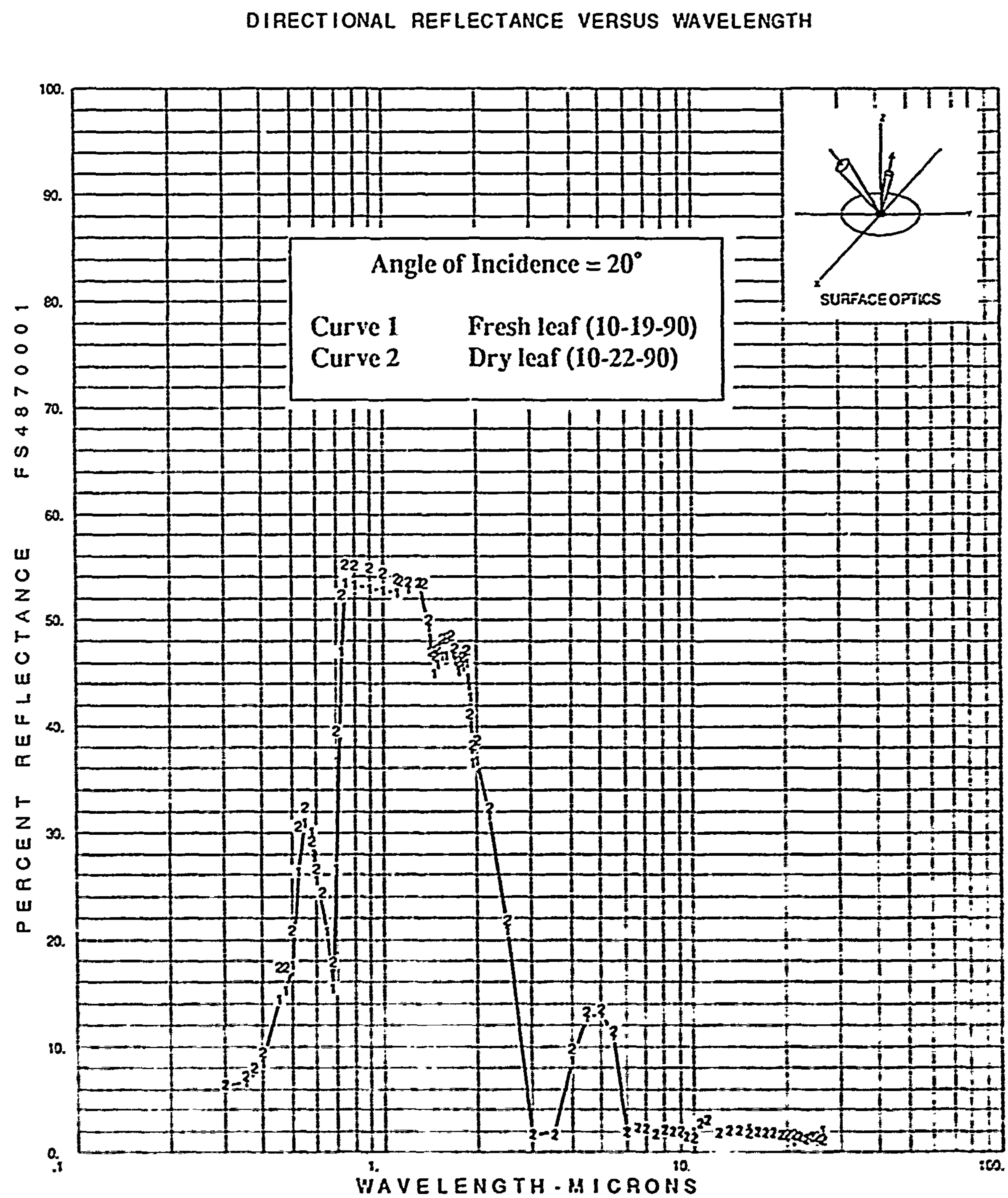

FIGURE I-1. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
BOTTOM OF LEAF C
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 26.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX I

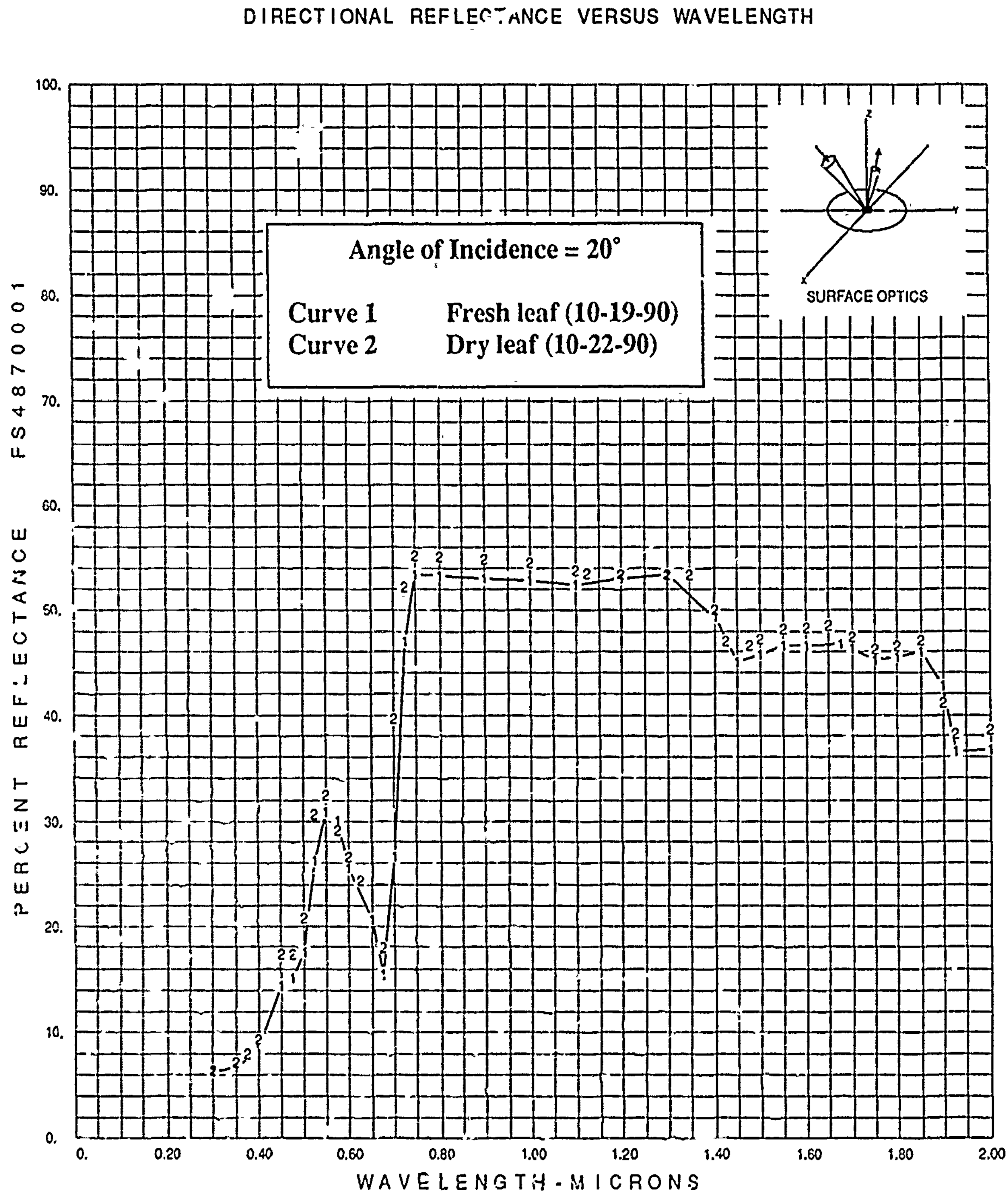

FIGURE I-2. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
BOTTOM OF LEAF C
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 2.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX I

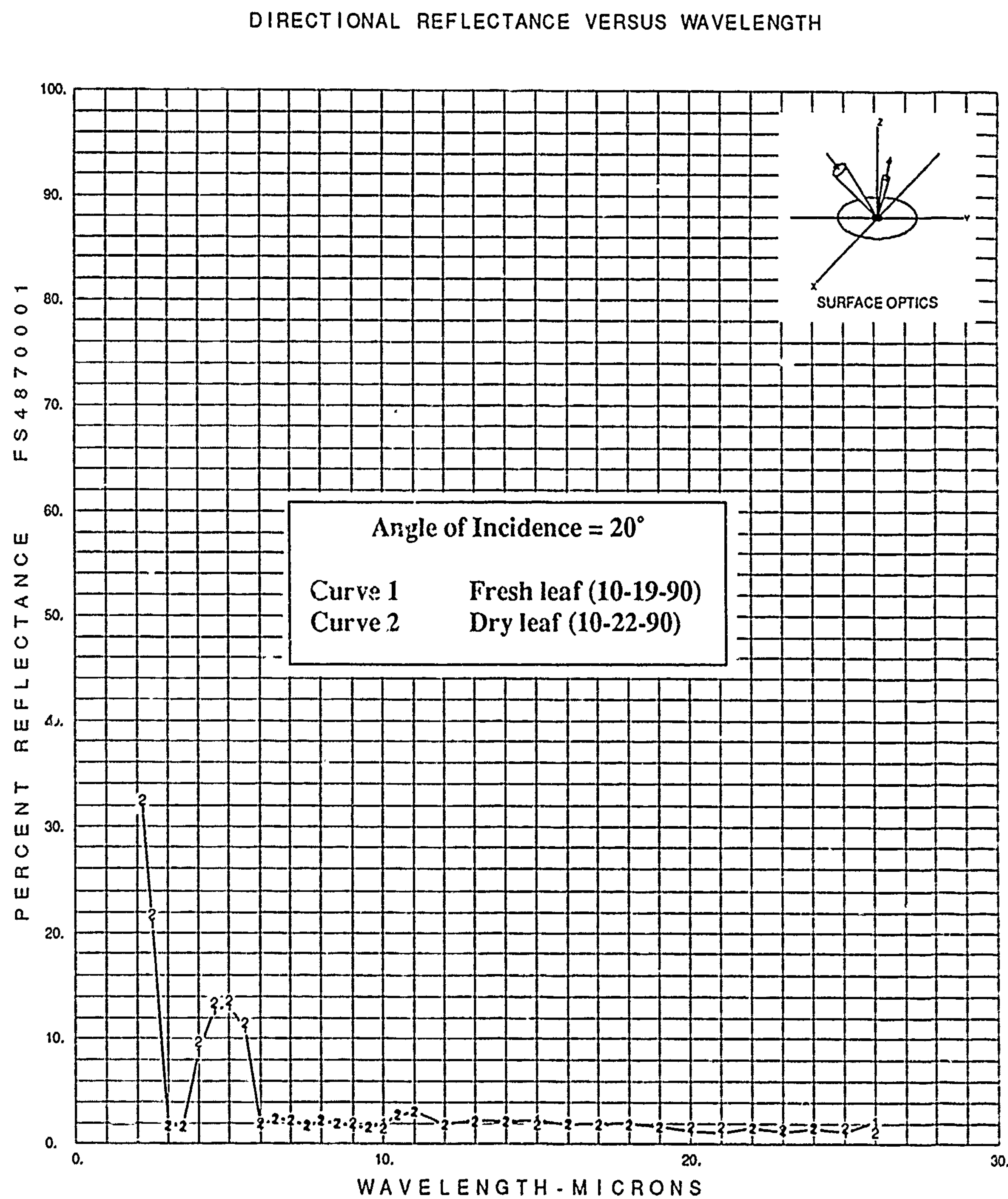

FIGURE I-3. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
BOTTOM OF LEAF C
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 2.2 TO 26.? MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX I

TABLE I-1. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
BOTTOM OF LEAF C
DIRECTIONAL REFLECTANCE VS. WAVELENGTH - ERAS DATA
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION
CURVE 1 - FRESH LEAF, CURVE 2 - DRY LEAF

FS48700015001		2	1								
FS48700015101		SPECTRAL SCIENCES: GREEN ASPEN LEAF. BOTTOM OF LEAF C									
FS48700015102		Curve 1 measured 10-19-90, Curve 2 measured 10-22-90									
FS48700015103		UNCORRECTED FOR INSTRUMENTATION POLARIZATION EFFECTS									
FS48700017001		101990 and 102290									
FS48700019001	1	001	1	.3	26.	68				20.	0.
FS48700019201	1	.3	6.3	.35	6.6	.4	8.5	.45	14.4	.475	15.2
FS48700019202	1	.5	17.6	.525	26.3	.55	30.9	.575	30.1	.6	25.6
FS48700019203	1	.65	20.7	.675	15.5	.7	26.7	.725	47.0	.75	53.4
FS48700019204	1	.8	53.3	.9	53.0	1.	52.8	1.1	52.5	1.2	53.0
FS48700019205	1	1.3	53.5	1.4	49.3	1.45	45.0	1.5	45.8	1.55	46.7
FS48700019206	1	1.6	46.7	1.675	46.8	1.7	46.3	1.75	45.2	1.8	45.6
FS48700019207	1	1.85	46.0	1.9	42.7	1.925	36.6	2.	36.8	2.2	31.6
FS48700019208	1	2.5	20.9	3.	1.7	3.5	1.8	4.	8.7	4.5	12.7
FS48700019209	1	5.	13.1	5.5	11.0	6.	1.8	6.5	2.4	7.	2.3
FS48700019210	1	7.5	1.7	8.	2.1	8.5	2.0	9.	1.7	9.5	1.6
FS48700019211	1	10.	2.0	10.5	2.7	11.	3.1	12.	1.9	13.	2.2
FS48700019212	1	14.	2.1	15.	2.3	16.	1.9	17.	2.0	18.	2.0
FS48700019213	1	19.	1.7	20.	1.3	21.	1.0	22.	1.6	23.	1.2
FS48700019214	1	24.	1.5	25.	1.1	26.	2.1				
FS48700019001	2	001	1	.3	26.	72				20.	0.
FS48700019201	2	.3	6.4	.35	7.2	.375	8.0	.4	9.4	.45	17.4
FS48700019202	2	.475	17.4	.5	20.8	.525	30.6	.55	32.4	.575	29.1
FS48700019203	2	.6	26.7	.625	24.4	.675	17.9	.7	39.6	.725	52.3
FS48700019204	2	.75	55.2	.8	55.1	.9	54.9	1.	54.5	1.1	53.8
FS48700019205	2	1.125	53.6	1.2	53.5	1.3	53.4	1.35	53.4	1.4	50.1
FS48700019206	2	1.425	47.0	1.475	46.7	1.5	47.2	1.55	48.2	1.6	48.3
FS48700019207	2	1.65	48.5	1.7	47.4	1.75	46.2	1.8	46.6	1.85	47.1
FS48700019208	2	1.9	41.2	1.925	38.2	2.	38.7	2.2	32.4	2.5	21.8
FS48700019209	2	3.	1.8	3.5	1.7	4.	9.7	4.5	13.3	5.	13.5
FS48700019210	2	5.5	11.5	6.	2.0	6.5	2.4	7.	2.3	7.5	1.8
FS48700019211	2	8.	2.2	8.5	2.0	9.	2.0	9.5	1.6	10.	1.5
FS48700019212	2	10.5	2.8	11.	3.1	12.	1.9	13.	2.1	14.	2.1
FS48700019213	2	15.	1.9	16.	2.0	17.	1.9	18.	1.9	19.	1.7
FS48700019214	2	20.	1.7	21.	1.7	22.	1.6	23.	1.4	24.	1.6
FS48700019215	2	25.	1.6	26.	1.2						

APPENDIX J

SPECTRAL SCIENCES INC.
GREEN ASPEN LEAF,
TOP OF LEAF B
FS4871:

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DIRECTIONAL REFLECTANCE

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APPENDIX J

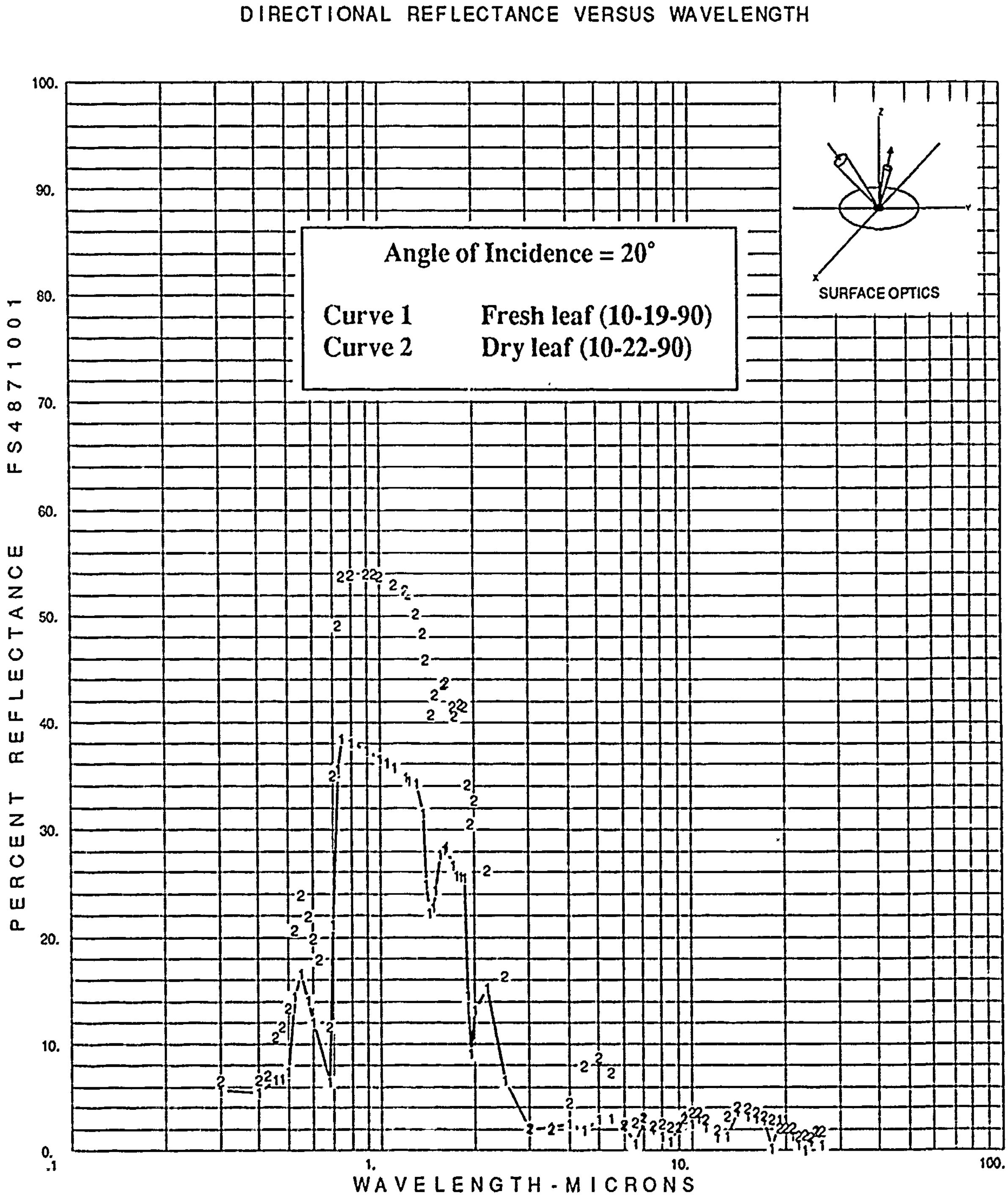

FIGURE J-1. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
TOP OF LEAF B
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 26.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX J

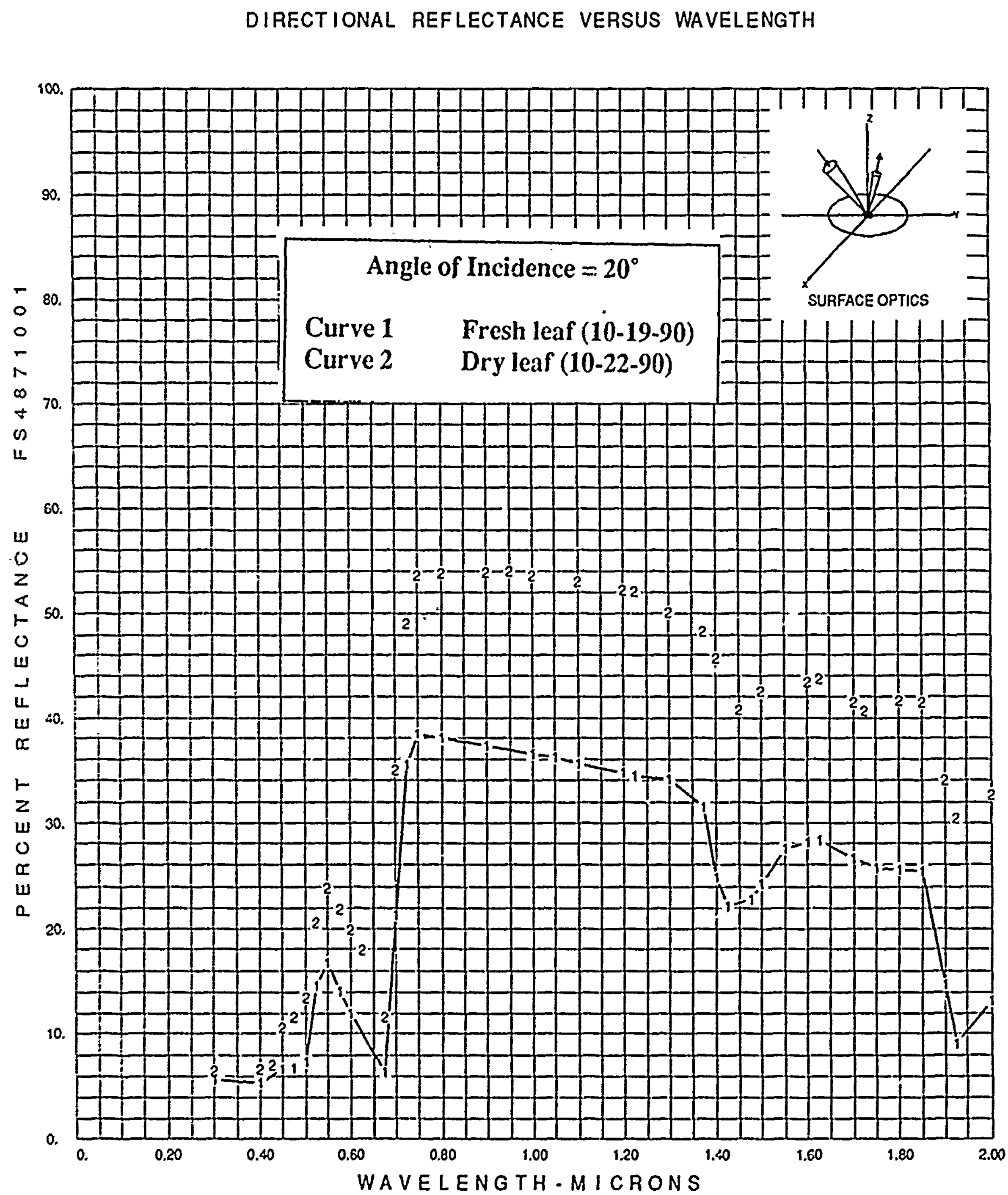

FIGURE J-2. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
TOP OF LEAF B
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 2.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

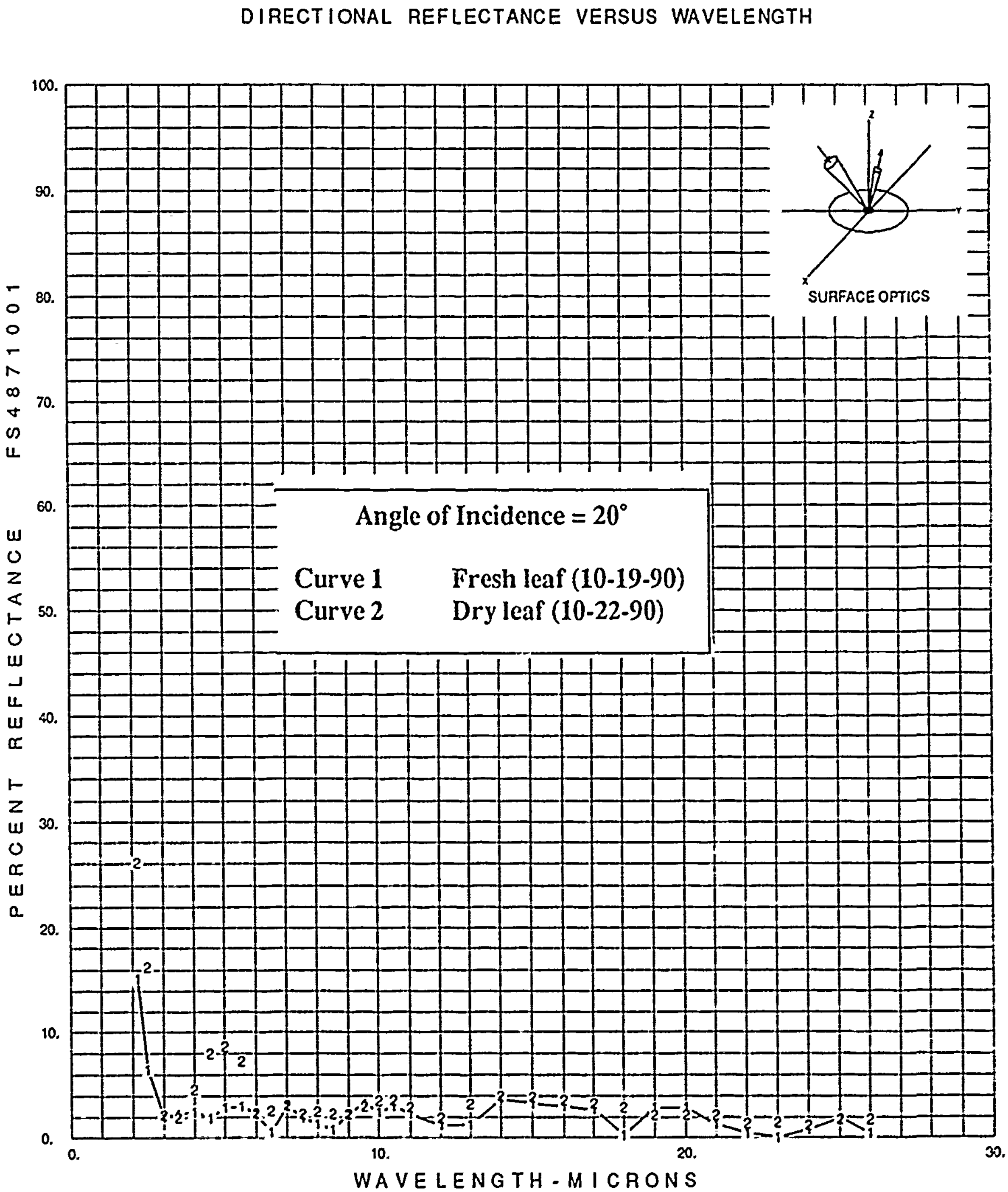

FIGURE J-3. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
TOP OF LEAF B
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 2.2 TO 26.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX J

TABLE J-1. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
TOP OF LEAF B
DIRECTIONAL REFLECTANCE VS. WAVELENGTH - ERAS DATA
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION
CURVE 1 - FRESH LEAF, CURVE 2 - DRY LEAF

FS48710015001		2	1								
FS48710015101		SPECTRAL SCIENCES: GREEN ASPEN LEAF. TOP OF LEAF B									
FS48710015102		Curve 1 measured 10-19-90, Curve 2 measured 10-22-90									
FS48710015103		UNCORRECTED FOR INSTRUMENTATION POLARIZATION EFFECTS									
FS48710017001		101990 and 102290									
FS48710019001	1	001	1	.3	26.	70				20.	0.
FS48710019201	1	.3	5.7	.4	5.4	.45	6.6	.475	6.7	.5	7.4
FS48710019202	1	.525	14.5	.55	16.7	.575	14.1	.6	12.0	.675	6.4
FS48710019203	1	.7	21.2	.725	35.6	.75	38.4	.8	38.0	.9	37.3
FS48710019204	1	1.	36.6	1.05	36.2	1.1	35.7	1.2	34.7	1.225	34.5
FS48710019205	1	1.3	34.2	1.375	31.4	1.4	24.8	1.425	22.2	1.475	22.7
FS48710019206	1	1.5	24.3	1.55	27.6	1.6	28.1	1.625	28.3	1.7	26.7
FS48710019207	1	1.75	25.7	1.8	25.6	1.85	25.5	1.9	14.6	1.925	9.1
FS48710019208	1	2.	13.2	2.2	15.2	2.5	6.5	3.	2.0	3.5	2.2
FS48710019209	1	4.	2.5	4.5	1.9	5.	2.9	5.5	3.0	6.	2.2
FS48710019210	1	6.5	0.6	7.	3.0	7.5	2.0	8.	1.3	8.5	0.8
FS48710019211	1	9.	2.3	9.5	3.2	10.	2.5	10.5	3.0	11.	2.2
FS48710019212	1	12.	1.2	13.	1.3	14.	3.7	15.	3.2	16.	3.0
FS48710019213	1	17.	2.7	18.	0.3	19.	2.9	20.	2.9	21.	1.3
FS48710019214	1	22.	0.5	23.	0.0	24.	0.8	25.	1.9	26.	0.5
FS48710019001	2	001	1	.3	26.	70				20.	0.
FS48710019201	2	.3	6.5	.4	6.6	.425	7.1	.45	10.6	.475	11.6
FS48710019202	2	.5	13.4	.525	20.6	.55	23.9	.575	21.9	.6	19.9
FS48710019203	2	.625	17.9	.675	11.6	.7	35.0	.725	49.1	.75	53.7
FS48710019204	2	.8	53.8	.9	53.9	.95	54.0	1.	53.7	1.1	53.0
FS48710019205	2	1.2	52.3	1.225	52.1	1.3	50.2	1.375	48.3	1.4	45.8
FS48710019206	2	1.45	40.7	1.5	42.5	1.6	43.5	1.625	43.7	1.7	41.4
FS48710019207	2	1.725	40.6	1.8	41.6	1.85	41.4	1.9	34.1	1.925	30.4
FS48710019208	2	2.	32.6	2.2	26.1	2.5	16.3	3.	2.1	3.5	2.0
FS48710019209	2	4.	4.5	4.5	7.9	5.	8.7	5.5	7.3	6.	2.4
FS48710019210	2	6.5	2.6	7.	3.1	7.5	2.3	8.	2.5	8.5	2.2
FS48710019211	2	9.	2.2	9.5	3.0	10.	3.6	10.5	3.6	11.	2.9
FS48710019212	2	12.	1.9	13.	3.2	14.	4.0	15.	3.9	16.	3.6
FS48710019213	2	17.	3.2	18.	2.9	19.	2.1	20.	2.1	21.	2.1
FS48710019214	2	22.	1.4	23.	1.5	24.	1.2	25.	1.8	26.	1.8

APPENDIX K

SPECTRAL SCIENCES INC.
GREEN ASPEN LEAF,
TOP OF LEAF D
FS4872:

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PAGE NO.

DIRECTIONAL REFLECTANCE

APPENDIX K

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APPENDIX K

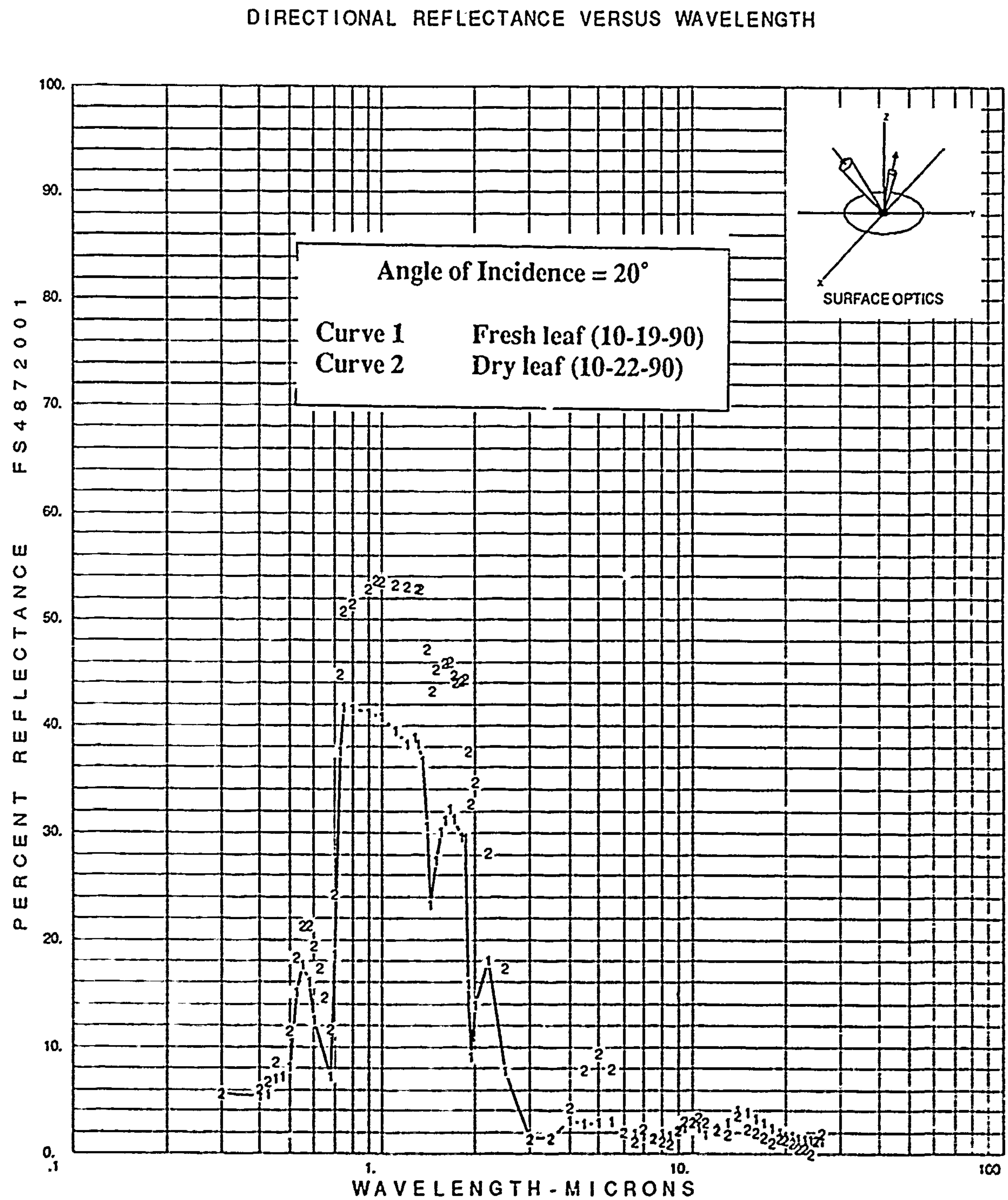

FIGURE K-1. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
TOP OF LEAF D
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 26.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX K

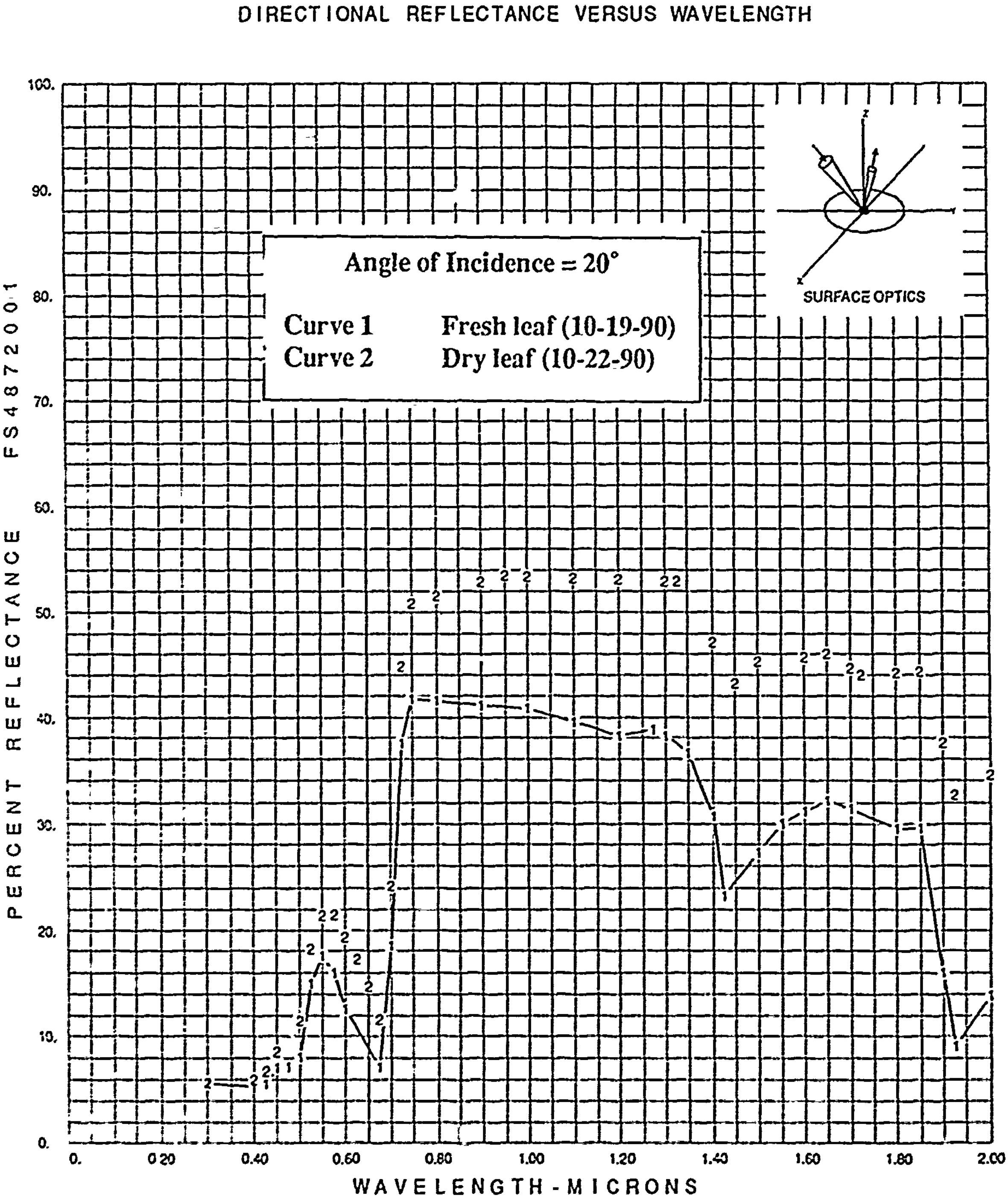

FIGURE K-2. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
TOP OF LEAF D
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 2.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX K

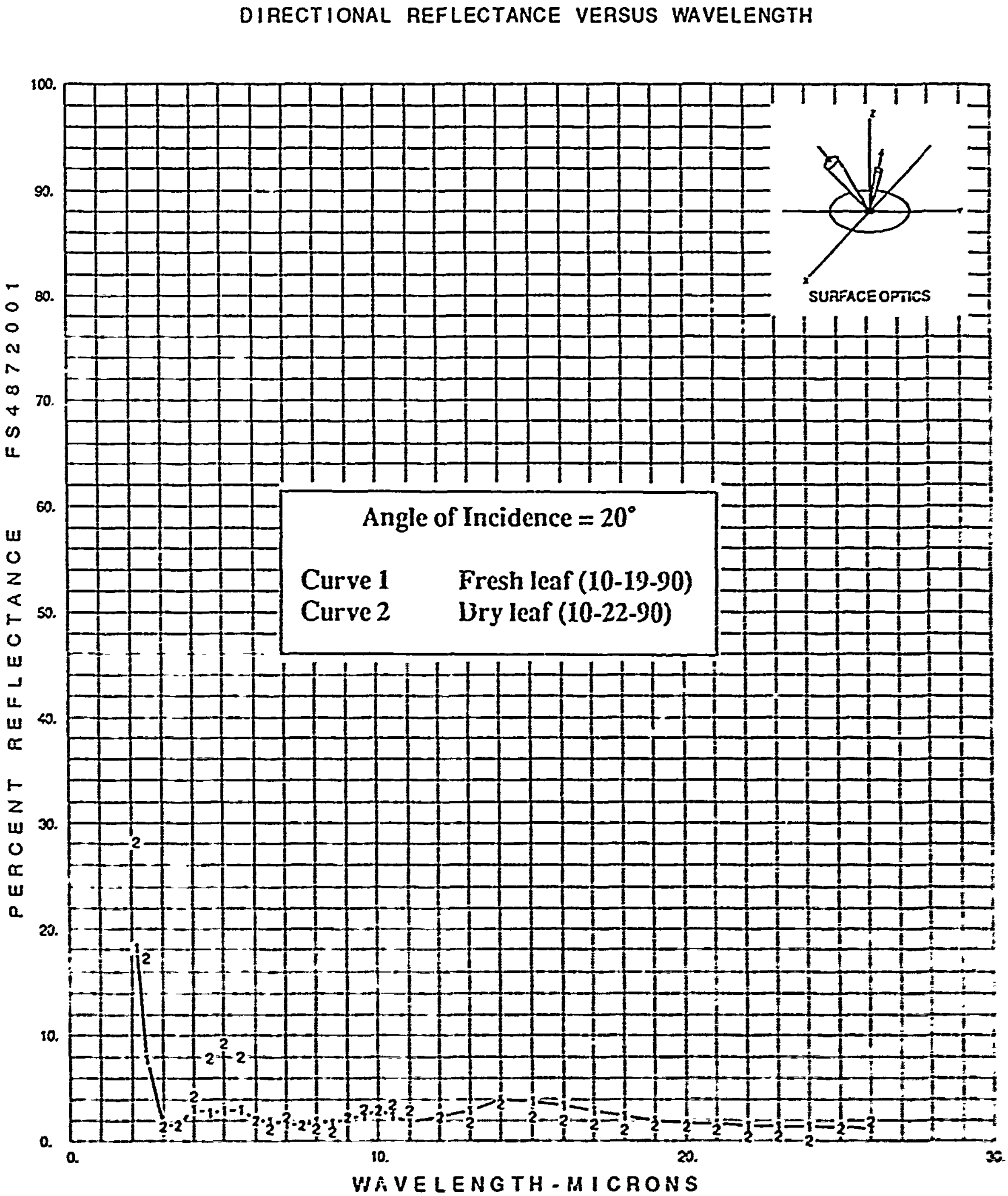

FIGURE K-3. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
TOP OF LEAF D
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 2.2 TO 26.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX K

TABLE K-1. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
TOP OF LEAF D
DIRECTIONAL REFLECTANCE VS. WAVELENGTH - ERAS DATA
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION
CURVE 1 - FRESH LEAF, CURVE 2 - DRY LEAF

FS48720015001		2	1								
FS48720015101		SPECTRAL SCIENCES: GREEN ASPEN LEAF. TOP OF LEAF D									
FS48720015102		Curve 1 measured 10-19-90, Curve 2 measured 10-22-90									
FS48720015103		UNCORRECTED FOR INSTRUMENTATION POLARIZATION EFFECTS									
FS48720017001		101990 and 102290									
FS48720019001	1	001	1	.3	26.	68				20.	0.
FS48720019201	1	.3	5.7	.4	5.3	.425	5.5	.45	7.1	.475	7.2
FS48720019202	1	.5	8.1	.525	15.0	.55	17.6	.575	16.0	.6	12.6
FS48720019203	1	.675	7.2	.7	18.6	.725	37.6	.75	41.7	.8	41.5
FS48720019204	1	.9	41.2	1.	40.8	1.1	39.5	1.2	38.2	1.275	38.9
FS48720019205	1	1.3	38.2	1.35	36.7	1.4	30.6	1.425	23.3	1.5	27.4
FS48720019206	1	1.55	30.1	1.6	31.2	1.65	32.2	1.7	31.3	1.8	29.6
FS48720019207	1	1.85	29.5	1.9	15.9	1.925	9.1	2.	13.9	2.2	18.1
FS48720019208	1	2.5	7.7	3.	1.5	3.5	1.6	4.	3.1	4.5	2.7
FS48720019209	1	5.	2.9	5.5	3.0	6	2.0	6.5	1.9	7.	1.7
FS48720019210	1	7.5	1.5	8.	1.9	8.5	1.7	9.	2.1	9.5	2.4
FS48720019211	1	10.	3.0	10.5	2.4	11.	1.8	12.	2.4	13.	2.9
FS48720019212	1	14.	4.0	15.	3.8	16.	3.3	17.	2.9	18.	2.4
FS48720019213	1	19.	2.0	20.	1.7	21.	1.7	22.	1.5	23.	1.4
FS48720019214	1	24.	1.4	25.	1.4	26.	1.2				
FS48720019001	2	001	1	.3	26.	69				20.	0.
FS48720019201	2	.3	5.6	.4	6.0	.425	6.7	.45	8.6	.5	11.5
FS48720019202	2	.525	18.3	.55	21.3	.575	21.4	.6	19.3	.625	17.3
FS48720019203	2	.65	14.6	.675	11.6	.7	24.2	.725	44.8	.75	50.8
FS48720019204	2	.8	51.5	.9	52.9	.95	53.6	1.	53.5	1.1	53.3
FS48720019205	2	1.2	53.1	1.3	52.9	1.325	52.9	1.4	47.1	1.45	43.3
FS48720019206	2	1.5	45.3	1.6	45.8	1.65	46.0	1.7	44.7	1.725	44.0
FS48720019207	2	1.8	44.2	1.85	44.4	1.9	37.5	1.925	32.6	2.	34.6
FS48720019208	2	2.2	28.1	2.5	17.3	3.	1.4	3.5	1.5	4.	4.3
FS48720019209	2	4.5	7.8	5.	9.3	5.5	7.9	6.	2.0	6.5	1.1
FS48720019210	2	7.	2.3	7.5	1.5	8.	1.1	8.5	0.9	9.	2.2
FS48720019211	2	9.5	3.0	10.	2.9	10.5	3.4	11.	2.9	12.	2.2
FS48720019212	2	13.	1.8	14.	3.6	15.	2.3	16.	2.0	17.	1.6
FS48720019213	2	18.	1.0	19.	1.5	20.	1.4	21.	1.0	22.	0.5
FS48720019214	2	23.	0.5	24.	0.0	25.	1.2	26.	1.9		

APPENDIX L

SPECTRAL SCIENCES INC.
GREEN ASPEN LEAF,
BOTTOM OF LEAF D
FS4873:

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APPENDIX L

DIRECTIONAL REFLECTANCE VERSUS WAVELENGTH

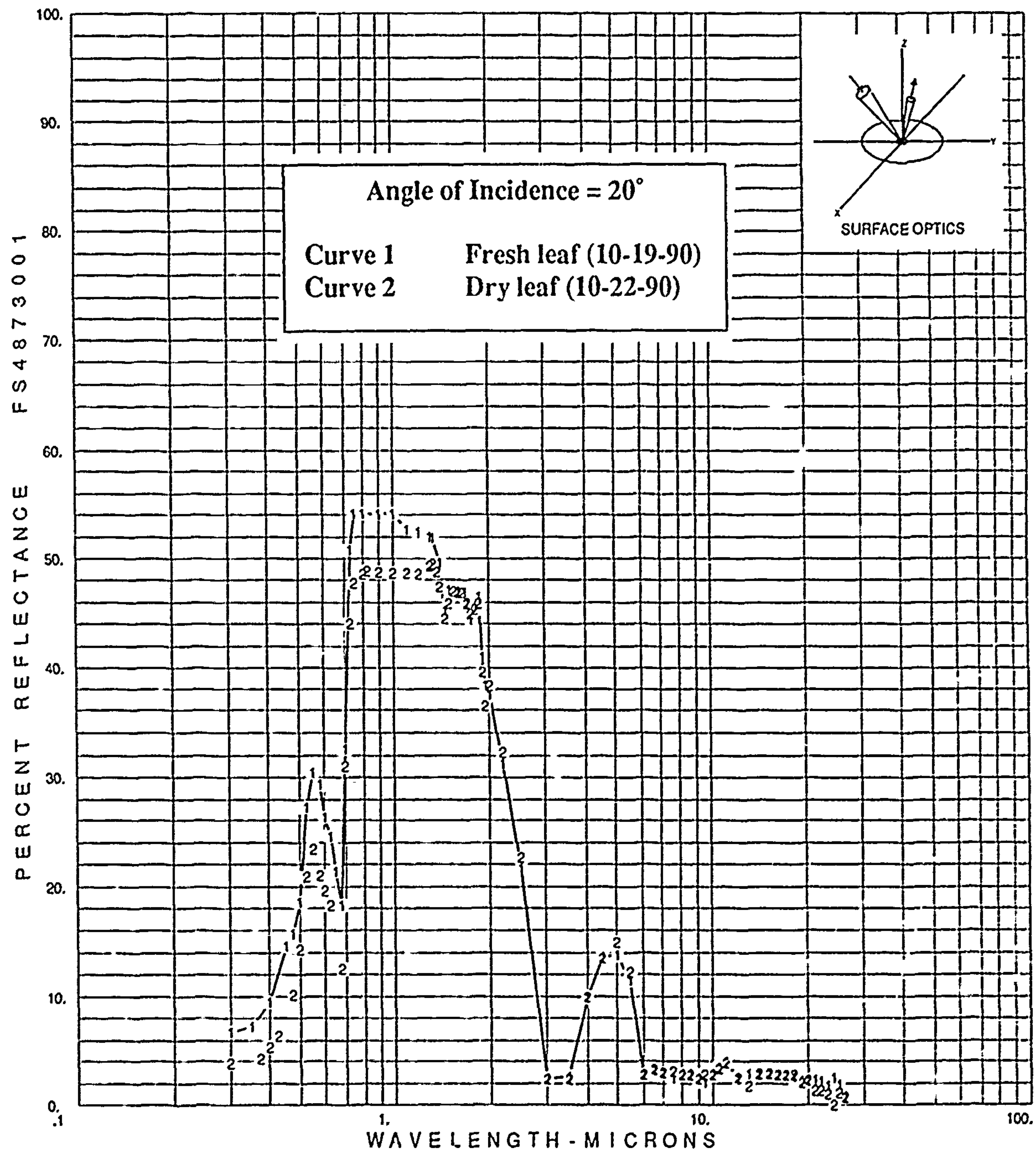

FIGURE L-1. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
BOTTOM OF LEAF D
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 26.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX L

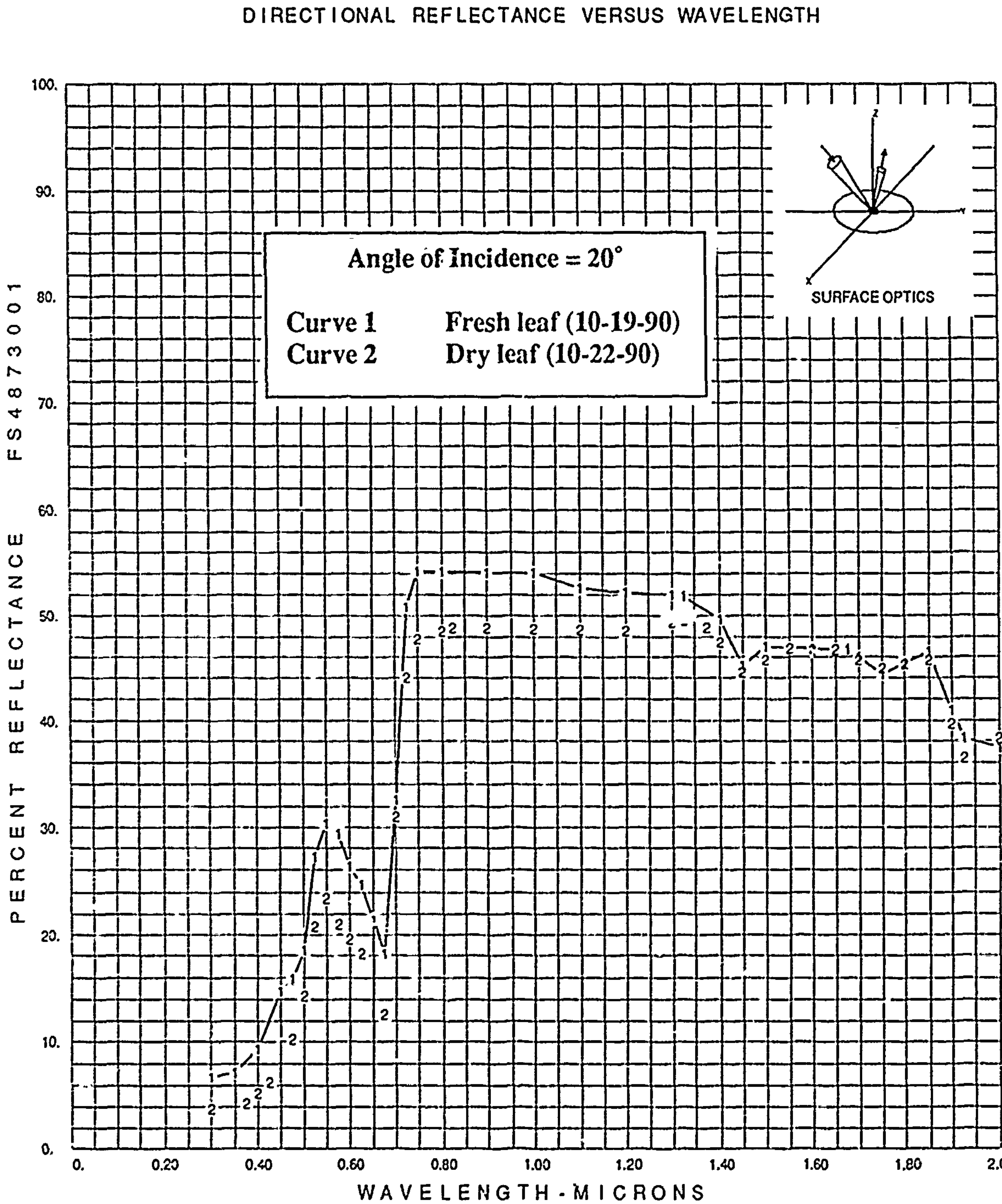

FIGURE L-2. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
BOTTOM OF LEAF D
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 2.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX L

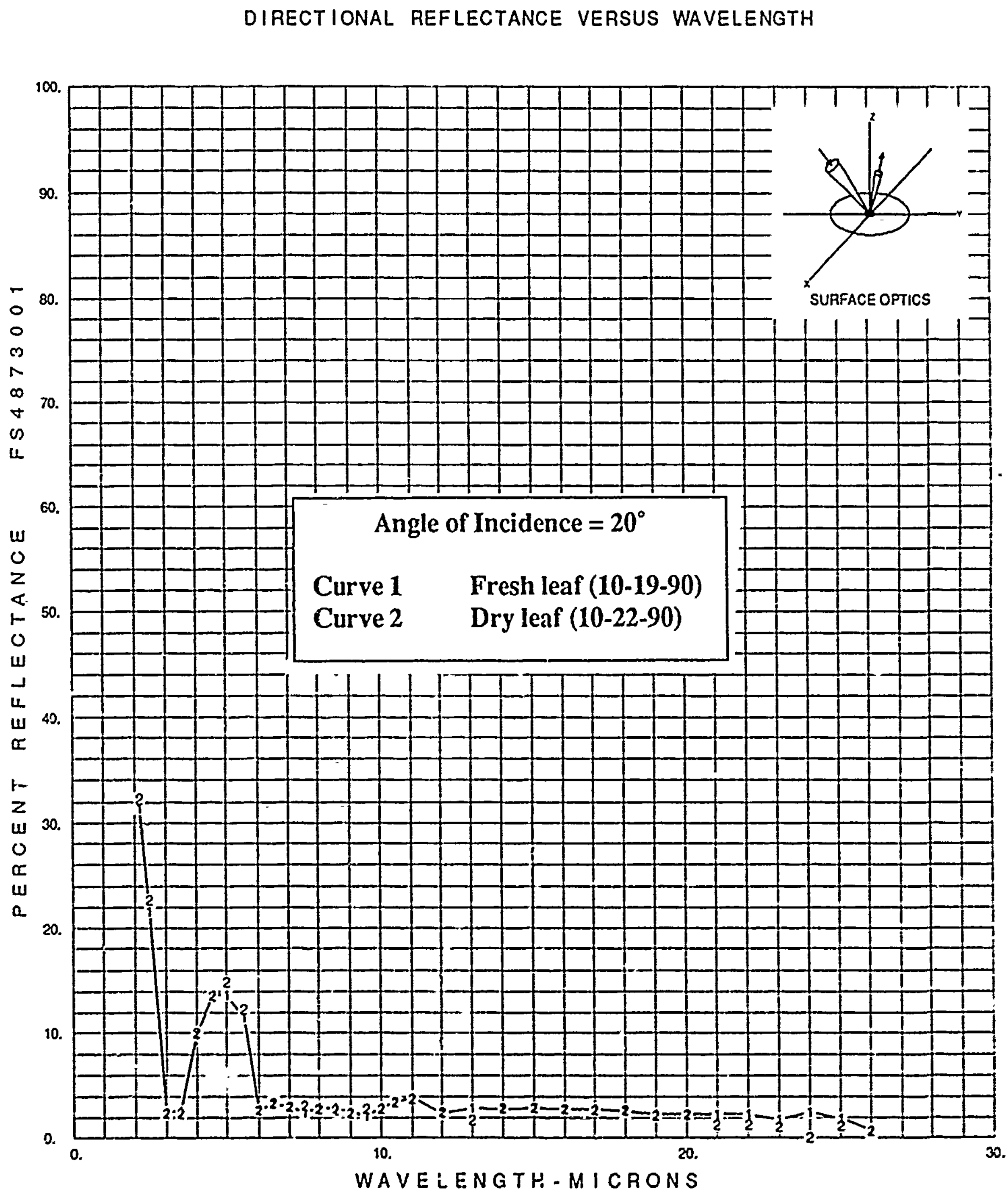

FIGURE L-3. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
BOTTOM OF LEAF D
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 2.2 TO 26.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX L

TABLE L-1. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
BOTTOM OF LEAF D
DIRECTIONAL REFLECTANCE VS. WAVELENGTH - ERAS DATA
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION
CURVE 1 - FRESH LEAF, CURVE 2 - DRY LEAF

FS48730015001		2	1								
FS48730015101		SPECTRAL SCIENCES: GREEN ASPEN LEAF. BOTTOM OF LEAF D									
FS48730015102		Curve 1 measured 10-19-90, Curve 2 measured 10-22-90									
FS48730015103		UNCORRECTED FOR INSTRUMENTATION POLARIZATION EFFECTS									
FS48730017001		101990 and 102290									
FS48730019001	1	001	1	.3	26.	69				20.	0.
FS48730019201	1	.3	6.7	.35	7.2	.4	9.4	.45	14.6	.475	15.3
FS48730019202	1	.5	18.6	.525	27.2	.55	30.3	.575	29.3	.6	26.4
FS48730019203	1	.625	24.6	.65	21.4	.675	18.3	.7	32.5	.725	50.8
FS48730019204	1	.75	54.2	.8	54.2	.9	54.1	1.	54.1	1.1	52.6
FS48730019205	1	1.2	52.3	1.3	52.0	1.325	51.9	1.4	49.6	1.45	45.2
FS48730019206	1	1.5	47.0	1.6	46.9	1.675	46.8	1.7	46.0	1.75	44.4
FS48730019207	1	1.8	45.5	1.85	46.5	1.9	41.0	1.925	38.3	2.	37.4
FS48730019208	1	2.2	31.3	2.5	21.6	3.	2.5	3.5	2.6	4.	9.9
FS48730019209	1	4.5	13.6	5.	13.7	5.5	11.5	6.	2.7	6.5	3.2
FS48730019210	1	7.	3.0	7.5	2.5	8.	2.9	8.5	2.9	9.	2.5
FS48730019211	1	9.5	2.1	10.	2.9	10.5	3.5	11.	3.9	12.	2.4
FS48730019212	1	13.	2.9	14.	2.8	15.	2.9	16.	2.8	17.	2.8
FS48730019213	1	18.	2.6	19.	2.3	20.	2.2	21.	2.3	22.	2.2
FS48730019214	1	23.	1.8	24.	2.5	25.	1.9	26.	0.8		
FS48730019001	2	001	1	.3	26.	71				20.	0.
FS48730019201	2	.3	3.8	.375	4.3	.4	5.3	.425	6.3	.475	10.2
FS48730019202	2	.5	14.3	.525	20.8	.55	23.4	.575	21.0	.6	19.6
FS48730019203	2	.625	18.3	.675	12.6	.7	31.0	.725	44.0	.75	47.8
FS48730019204	2	.8	48.5	.825	48.9	.9	48.8	1.	48.7	1.1	48.6
FS48730019205	2	1.2	48.5	1.3	49.3	1.325	49.5	1.375	48.8	1.4	47.4
FS48730019206	2	1.45	44.6	1.5	45.8	1.55	46.9	1.6	46.8	1.65	46.8
FS48730019207	2	1.7	45.8	1.75	44.9	1.8	45.3	1.85	45.8	1.9	39.6
FS48730019208	2	1.925	36.5	2.	38.3	2.2	32.3	2.5	22.6	3.	2.4
FS48730019209	2	3.5	2.4	4.	10.0	4.5	13.5	5.	14.9	5.5	12.2
FS48730019210	2	6.	2.7	6.5	3.3	7.	3.0	7.5	3.1	8.	2.8
FS48730019211	2	8.5	2.7	9.	2.4	9.5	2.8	10.	2.8	10.5	3.4
FS48730019212	2	11.	3.8	12.	2.5	13.	1.8	14.	2.9	15.	2.9
FS48730019213	2	16.	2.8	17.	2.7	18.	2.7	19.	2.1	20.	2.3
FS48730019214	2	21.	1.3	22.	1.3	23.	1.0	24.	0.0	25.	1.1
FS48730019215	2	26.	0.7								

APPENDIX M

SPECTRAL SCIENCES INC.
GREEN ASPEN LEAF,
TOP OF LEAF E
FS4874:

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DIRECTIONAL REFLECTANCE

APPENDIX M

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APPENDIX M

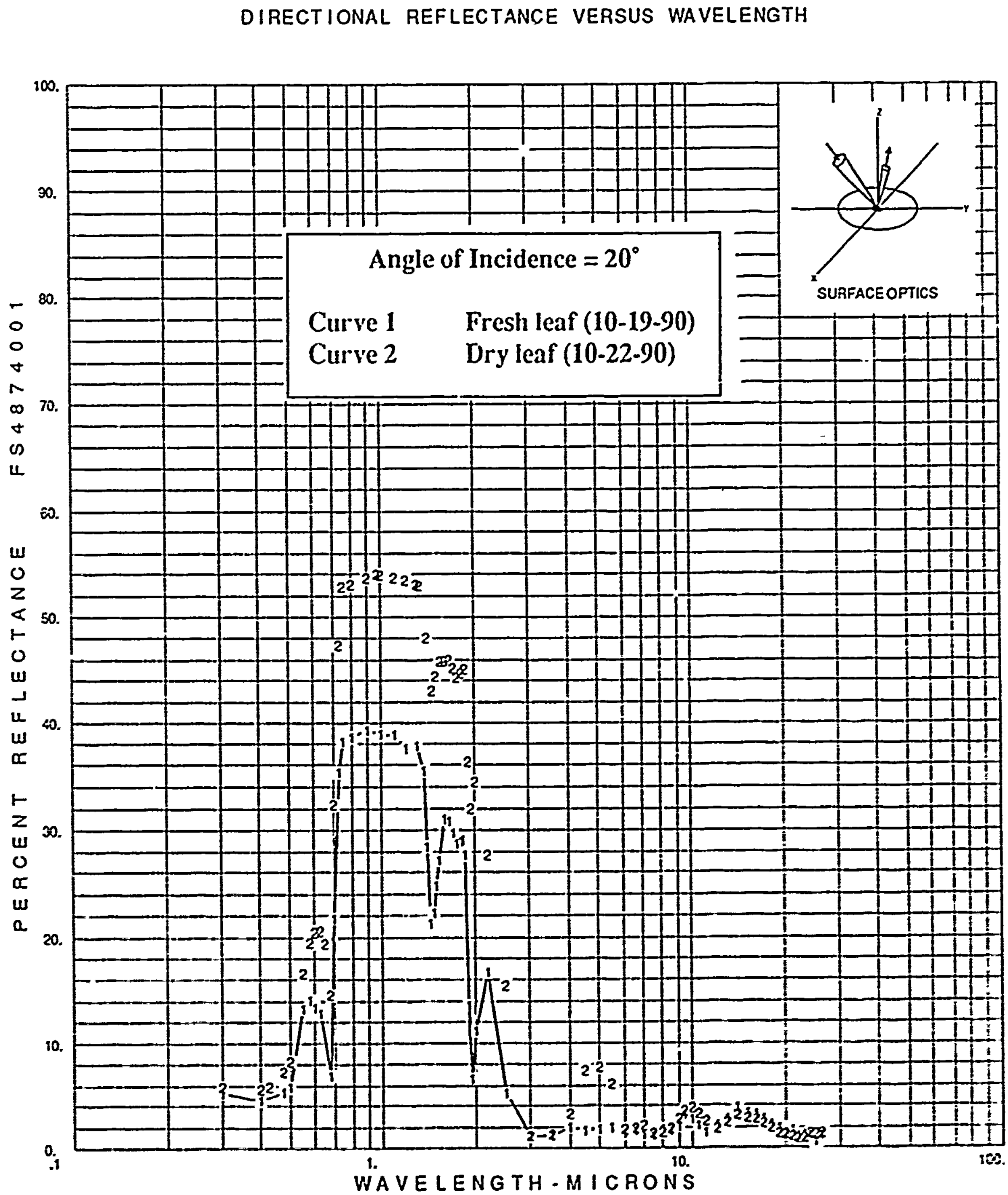

FIGURE M-1. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
TOP OF LEAF E
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 26.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

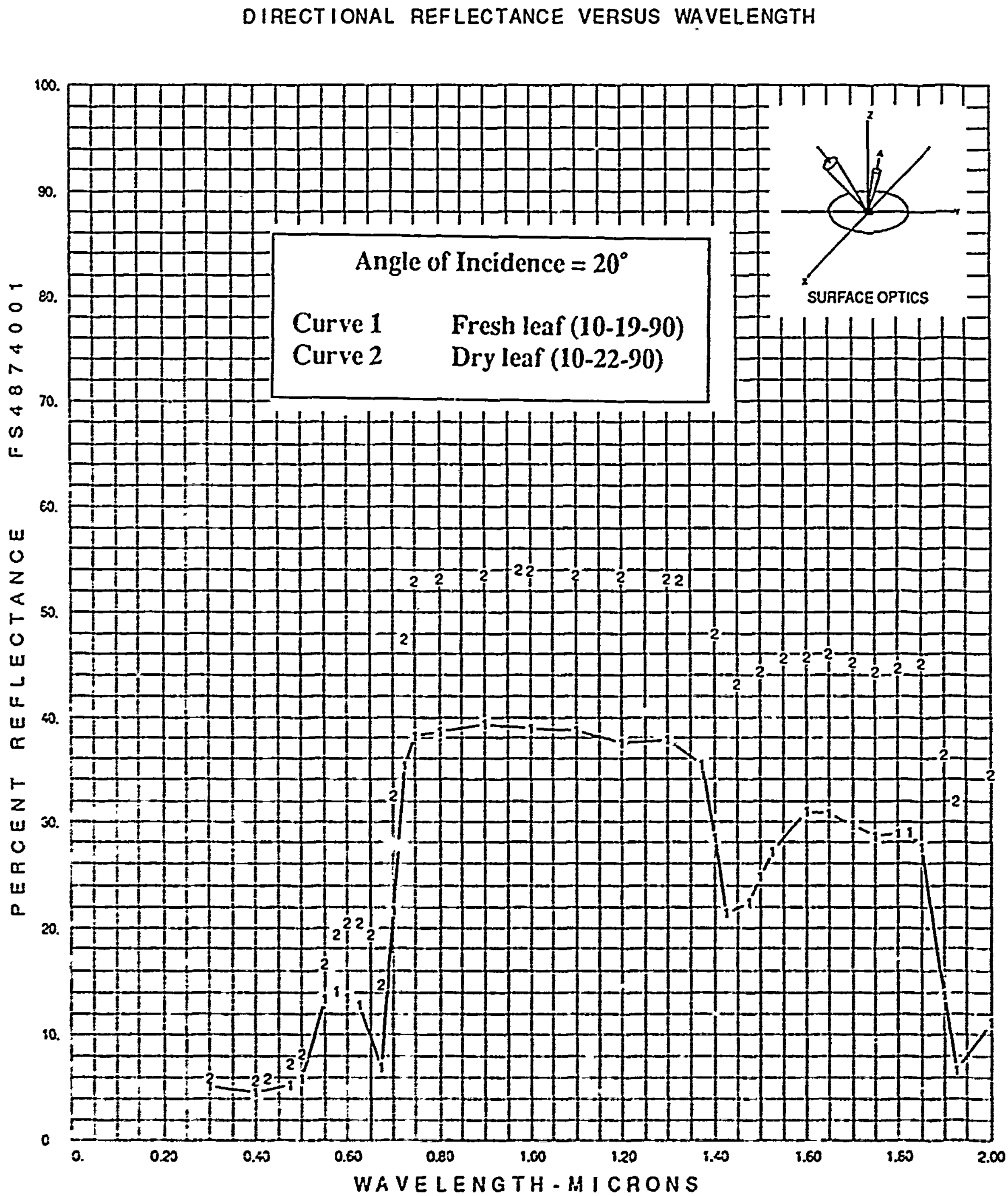

FIGURE M-2. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
TOP OF LEAF E
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 2.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX M

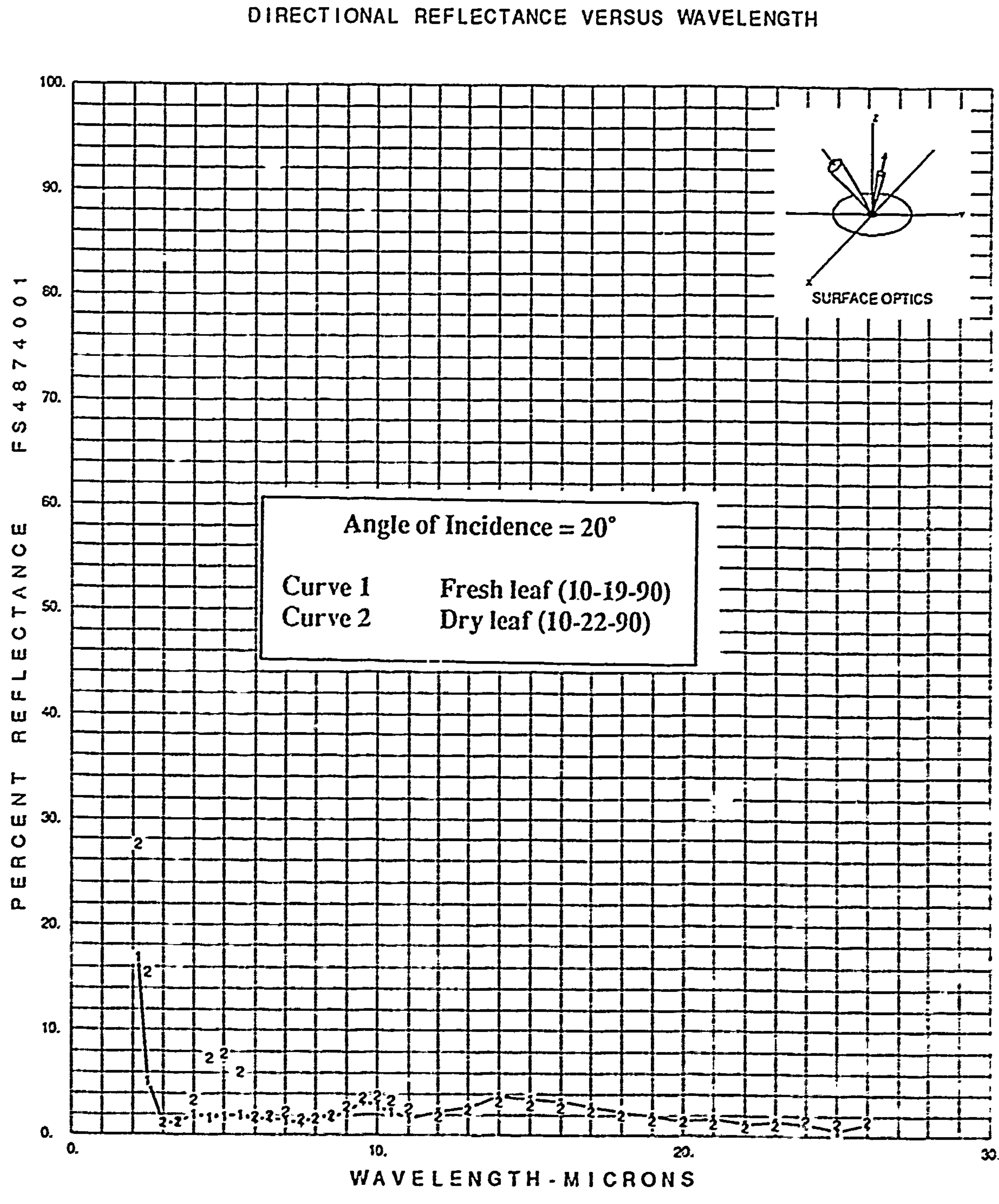

FIGURE M-3. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
TOP OF LEAF E
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 2.2 TO 26.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX M

TABLE M-1. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
TOP OF LEAF E
DIRECTIONAL REFLECTANCE VS. WAVELENGTH - ERAS DATA
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION
CURVE 1 - FRESH LEAF, CURVE 2 - DRY LEAF

FS48740015001		2	1								
FS48740015101		SPECTRAL SCIENCES: GREEN ASPEN LEAF. TOP OF LEAF E									
Fs48740015102		Curve 1 measured 10-19-90, Curve 2 measured 10-22-90									
FS48740015103		UNCORRECTED FOR INSTRUMENTATION POLARIZATION EFFECTS									
FS48740017001		101990 and 102290									
FS48740019001	1	001	1	.3	26.	68				20.	0.
FS48740019201	1	.3	5.2	.4	4.6	.475	5.3	.5	5.9	.55	13.3
FS48740019202	1	.575	14.1	.6	13.4	.625	12.8	.675	7.0	.7	21.7
FS48740019203	1	.725	35.4	.75	38.2	.8	38.6	.9	39.3	1.	39.0
FS48740019204	1	1.1	38.8	1.2	37.5	1.3	37.9	1.375	35.5	1.4	28.4
FS48740019205	1	1.425	21.3	1.475	22.3	1.5	24.7	1.525	27.1	1.6	31.0
FS48740019206	1	1.65	30.8	1.7	29.7	1.75	28.7	1.8	28.9	1.825	29.0
FS48740019207	1	1.85	27.6	1.9	13.6	1.925	6.6	2.	11.1	2.2	16.8
FS48740019208	1	2.5	5.2	3.	1.2	3.5	1.2	4.	2.0	4.5	1.7
FS48740019209	1	5.	1.8	5.5	2.0	6.	1.5	6.5	1.7	7.	1.4
FS48740019210	1	7.5	1.2	8.	1.8	8.5	1.7	9.	2.1	9.5	3.2
FS48740019211	1	10.	2.8	10.5	2.2	11.	1.6	12.	2.2	13.	2.7
FS48740019212	1	14.	3.8	15.	3.4	16.	3.2	17.	2.8	18.	2.3
FS48740019213	1	19.	1.9	20.	1.5	21.	1.7	22.	1.1	23.	1.4
FS48740019214	1	24.	1.2	25.	0.6	26.	1.2				
FS48740019001	2	001	1	.3	26.	69				20.	0.
FS48740019201	2	.3	5.9	.4	5.7	.425	5.9	.475	7.3	.5	8.2
FS48740019202	2	.55	16.6	.575	19.4	.6	20.4	.625	20.5	.65	19.3
FS48740019203	2	.675	14.6	.7	32.4	.725	47.4	.75	52.9	.8	53.1
FS48740019204	2	.9	53.6	.975	54.0	1.	53.9	1.1	53.6	1.2	53.4
FS48740019205	2	1.3	53.1	1.325	53.0	1.4	48.0	1.45	43.1	1.5	44.4
FS48740019206	2	1.55	45.7	1.6	45.8	1.65	46.0	1.7	45.2	1.75	44.3
FS48740019207	2	1.8	44.7	1.85	45.1	1.9	36.4	1.925	32.0	2.	34.5
FS48740019208	2	2.2	27.6	2.5	15.5	3.	1.2	3.5	1.3	4.	3.3
FS48740019209	2	4.5	7.4	5.	7.7	5.5	6.1	6.	1.8	6.5	1.9
FS48740019210	2	7.	2.2	7.5	1.5	8.	1.6	8.5	1.9	9.	2.8
FS48740019211	2	9.5	3.6	10.	3.8	10.5	3.3	11.	2.6	12.	1.9
FS48740019212	2	13.	2.5	14.	3.2	15.	2.9	16.	2.7	17.	2.4
FS48740019213	2	18.	2.0	19.	1.5	20.	1.4	21.	1.1	22.	0.9
FS48740019214	2	23.	1.0	24.	1.5	25.	1.3	26.	1.5		

APPENDIX N

SPECTRAL SCIENCES INC.
GREEN ASPEN LEAF,
BOTTOM OF LEAF E
FS4875:

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PAGE NO.

DIRECTIONAL REFLECTANCE

APPENDIX N

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APPENDIX N

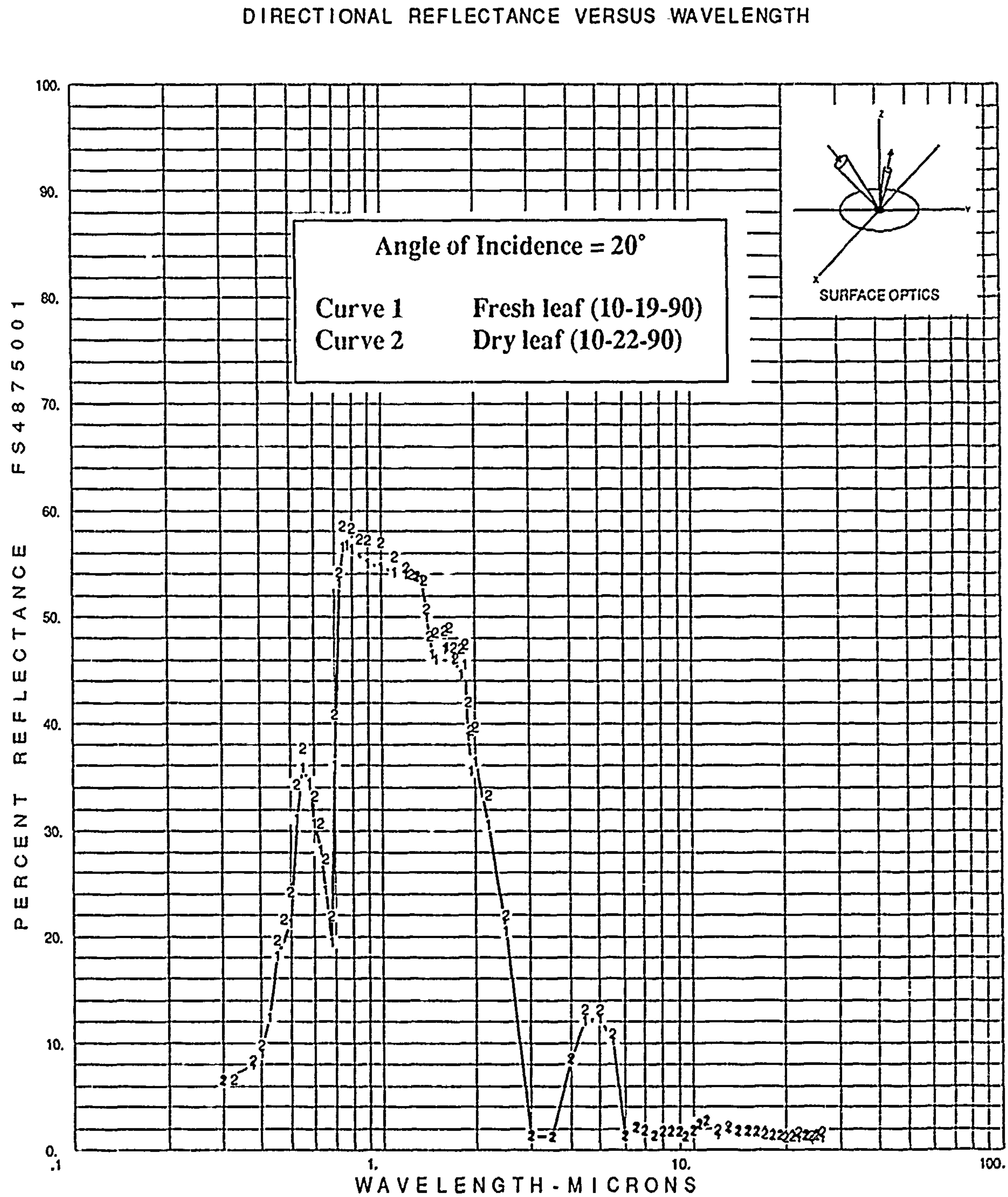

FIGURE N-1. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
BOTTOM OF LEAF E
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 26.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX N

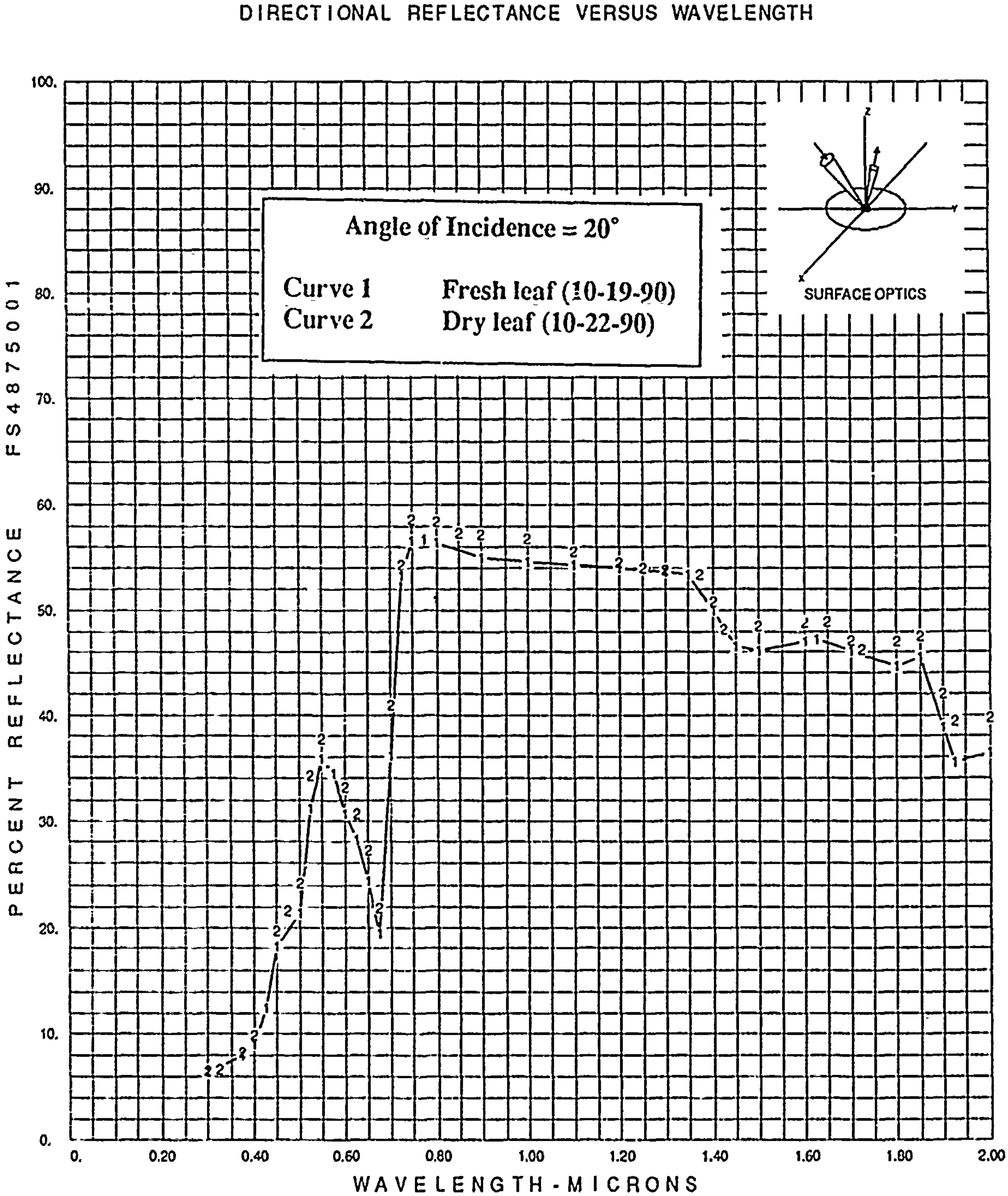

FIGURE N-2. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
BOTTOM OF LEAF E
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 2.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX N

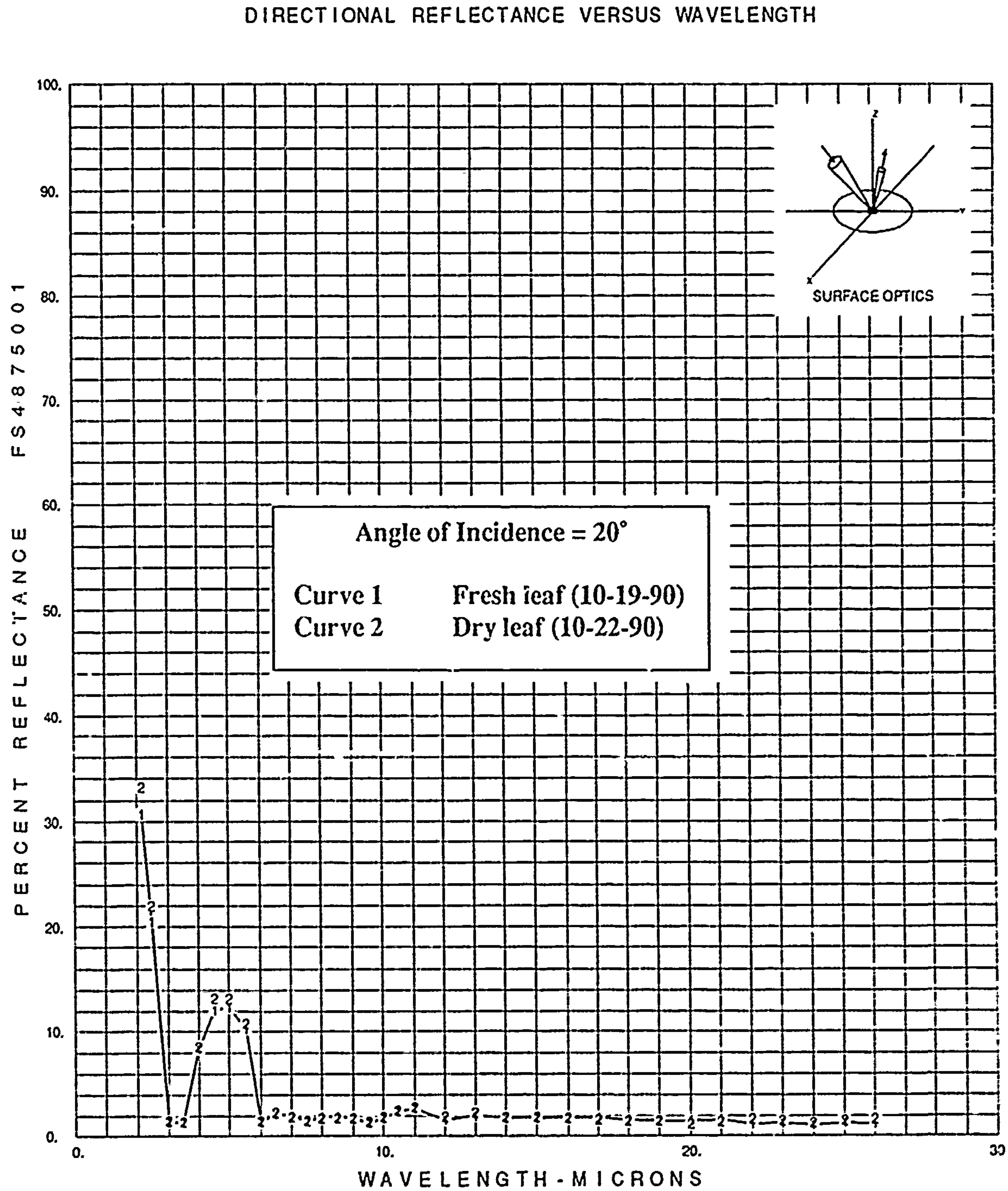

FIGURE N-3. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
BOTTOM OF LEAF E
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 2.2 TO 26.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX N

TABLE N-1. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
BOTTOM OF LEAF E
DIRECTIONAL REFLECTANCE VS. WAVELENGTH - ERAS DATA
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION
CURVE 1 - FRESH LEAF, CURVE 2 - DRY LEAF

FS48750015001		2	1								
FS48750015101		SPECTRAL SCIENCES: GREEN ASPEN LEAF. BOTTOM OF LEAF E									
FS48750015102		Curve 1 measured 10-19-90, Curve 2 measured 10-22-90									
FS48750015103		UNCORRECTED FOR INSTRUMENTATION POLARIZATION EFFECTS									
FS48750017001		101990 and 10-22-90									
FS48750019001	1	001	1	.3	26.	69				20.	0.
FS48750019201	1	.3	6.4	.375	8.0	.4	9.1	.425	12.4	.45	18.2
FS48750019202	1	.5	21.3	.525	31.2	.55	35.8	.575	34.5	.6	30.7
FS48750019203	1	.625	28.2	.65	24.4	.675	19.5	.7	36.1	.725	53.3
FS48750019204	1	.75	56.6	.775	56.7	.8	56.4	.9	55.0	1.	54.7
FS48750019205	1	1.1	54.3	1.2	54.0	1.3	53.7	1.35	53.5	1.4	50.1
FS48750019206	1	1.45	46.6	1.5	46.1	1.6	47.0	1.625	47.2	1.7	46.1
FS48750019207	1	1.8	44.7	1.85	45.6	1.9	38.9	1.925	35.6	2.	36.5
FS48750019208	1	2.2	30.6	2.5	20.5	3.	1.4	3.5	1.4	4.	8.4
FS48750019209	1	4.5	12.1	5.	12.3	5.5	10.3	6.	1.4	6.5	2.1
FS48750019210	1	7.	2.0	7.5	1.5	8.	1.9	8.5	1.9	9.	1.8
FS48750019211	1	9.5	1.3	10.	1.8	10.5	2.4	11.	2.7	12.	1.6
FS48750019212	1	13.	2.0	14.	1.8	15.	1.8	16.	1.8	17.	1.8
FS48750019213	1	18.	1.6	19.	1.5	20.	1.5	21.	1.6	22.	1.2
FS48750019214	1	23.	1.3	24.	1.0	25.	1.3	26.	1.2		
FS48750019001	2	001	1	.3	26.	71				20.	0.
FS48750019201	2	.3	6.5	.325	6.6	.375	8.3	.4	9.9	.45	19.7
FS48750019202	2	.475	21.6	.5	24.2	.525	34.3	.55	37.8	.6	33.2
FS48750019203	2	.625	30.7	.65	27.3	.675	21.9	.7	40.9	.725	54.3
FS48750019204	2	.75	58.6	.8	58.4	.85	57.3	.9	57.2	1.	56.9
FS48750019205	2	1.1	55.7	1.2	54.6	1.25	54.0	1.3	53.8	1.375	53.4
FS48750019206	2	1.4	50.8	1.425	48.2	1.5	48.5	1.6	48.8	1.65	49.0
FS48750019207	2	1.7	47.1	1.725	46.2	1.8	47.0	1.85	47.5	1.9	42.1
FS48750019208	2	1.925	39.4	2.	39.7	2.2	33.3	2.5	22.0	3.	1.5
FS48750019209	2	3.5	1.4	4.	8.6	4.5	13.2	5.	13.2	5.5	10.8
FS48750019210	2	6.	1.5	6.5	2.2	7.	1.9	7.5	1.5	8.	1.8
FS48750019211	2	8.5	1.8	9.	1.8	9.5	1.4	10.	1.9	10.5	2.5
FS48750019212	2	11.	2.8	12.	1.9	13.	2.2	14.	1.9	15.	1.9
FS48750019213	2	16.	1.8	17.	1.6	18.	1.5	19.	1.5	20.	1.2
FS48750019214	2	21.	1.4	22.	1.7	23.	1.5	24.	1.3	25.	1.5
FS48750019215	2	26.	1.7								

APPENDIX O

SPECTRAL SCIENCES INC.
GREEN ASPEN LEAF,
TOP OF LEAF F
FS4876:

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DIRECTIONAL REFLECTANCE

APPENDIX O

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APPENDIX O

DIRECTIONAL REFLECTANCE VERSUS WAVELENGTH

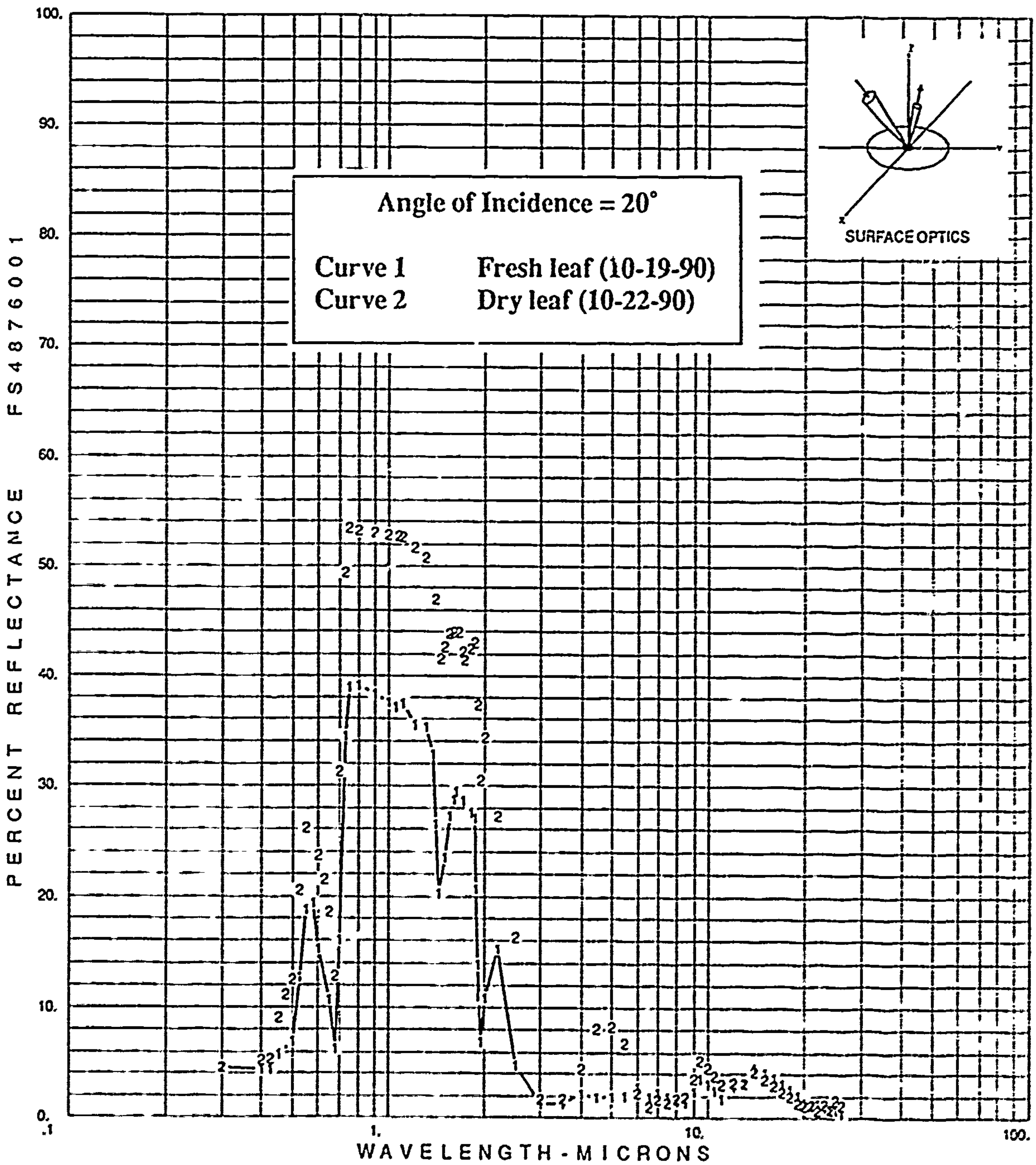

FIGURE O-1. SPEC RAL SCIENCES: GREEN ASPEN LEAF.
TOP OF LEAF F
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 26.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX O

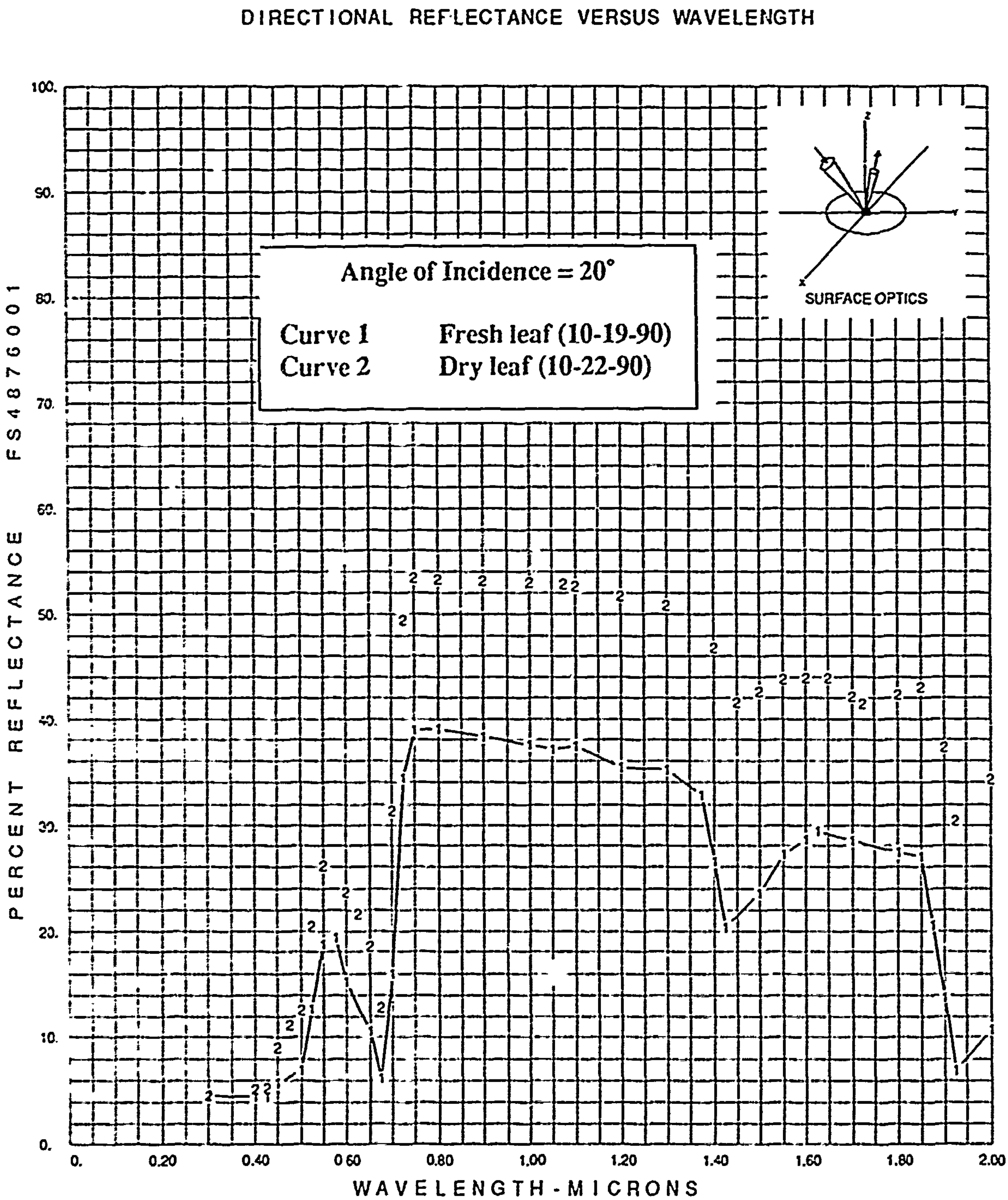

FIGURE O-2. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
TOP OF LEAF F
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 2.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX O

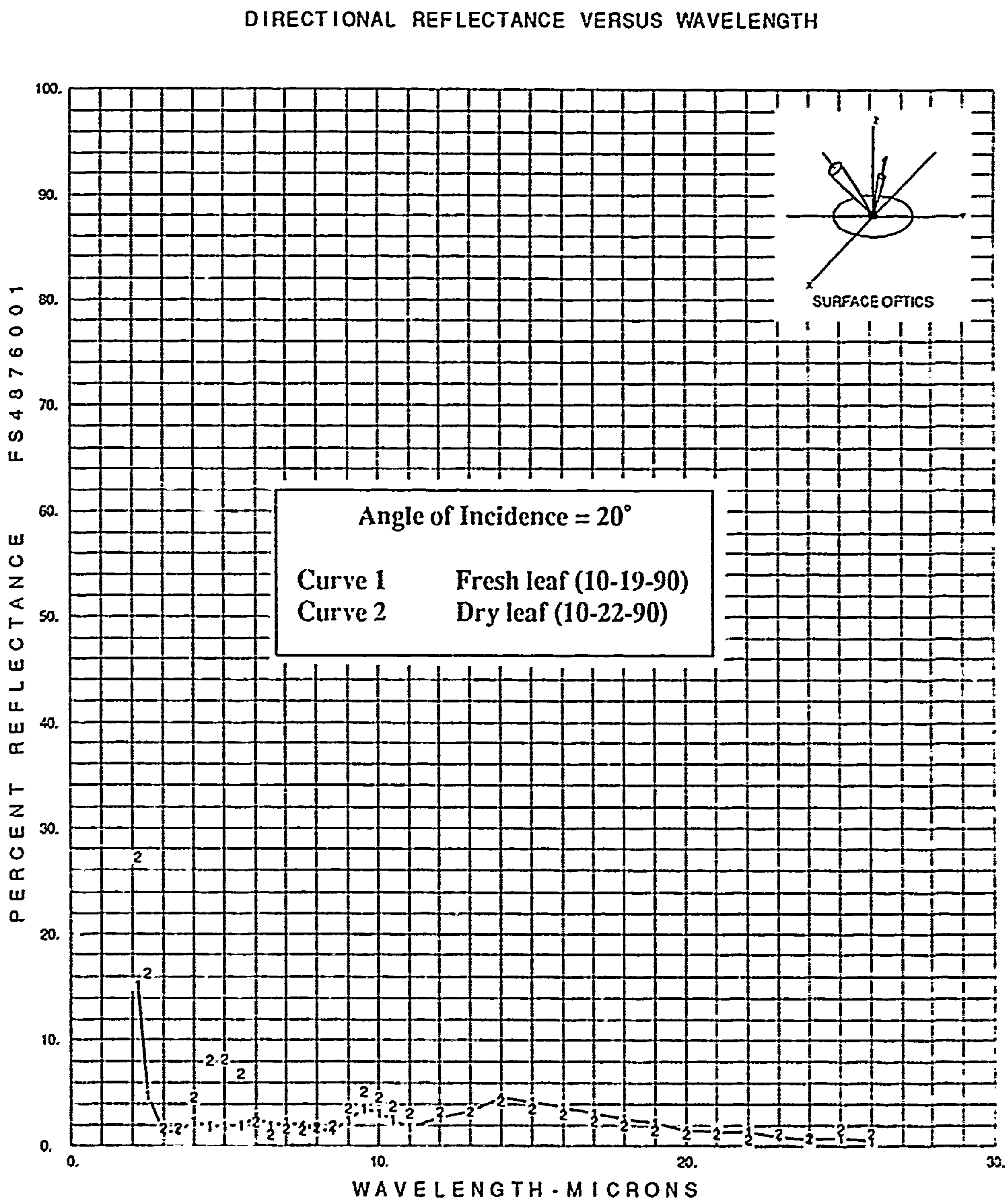

FIGURE O-3. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
TOP OF LEAF F
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 2.2 TO 26.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX O

TABLE O-1. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
TOP OF LEAF F
DIRECTIONAL REFLECTANCE VS. WAVELENGTH - ERAS DATA
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION
CURVE 1 - FRESH LEAF, CURVE 2 - DRY LEAF

FS48760015001		2	1								
FS48760015101		SPECTRAL SCIENCES: GREEN ASPEN LEAF. TOP OF LEAF F									
FS48760015102		Curve 1 measured 10-19-90, Curve 2 measured 10-22-90									
FS48760015103		UNCORRECTED FOR INSTRUMENTATION POLARIZATION EFFECTS									
FS48760017001		101990 and 102290									
FS48760019001	1	001	1	.3	26.	69				20.	0.
FS48760019201	1	.3	4.6	.4	4.4	.425	4.4	.45	5.8	.5	7.0
FS48760019202	1	.525	12.7	.55	18.8	.575	19.3	.6	15.3	.65	10.6
FS48760019203	1	.675	6.2	.7	16.0	.725	34.5	.75	39.0	.8	39.1
FS48760019204	1	.9	38.3	1.	37.5	1.05	37.1	1.1	37.4	1.2	35.5
FS48760019205	1	1.3	35.3	1.375	32.8	1.4	26.6	1.425	20.3	1.5	23.5
FS48760019206	1	1.55	27.2	1.6	28.7	1.625	29.4	1.7	28.6	1.8	27.5
FS48760019207	1	1.85	27.0	1.875	20.6	1.9	13.8	1.925	7.0	2.	10.8
FS48760019208	1	2.2	15.2	2.5	4.8	3.	1.3	3.5	1.4	4.	2.2
FS48760019209	1	4.5	1.9	5.	1.9	5.5	2.0	6.	2.7	6.5	1.9
FS48760019210	1	7.	2.3	7.5	1.9	8.	1.6	8.5	1.5	9.	2.4
FS48760019211	1	9.5	3.6	10.	3.1	10.5	2.5	11.	1.8	12.	2.7
FS48760019212	1	13.	3.2	14.	4.6	15.	4.2	16.	3.7	17.	3.1
FS48760019213	1	18.	2.6	19.	2.1	20.	1.5	21.	1.4	22.	1.4
FS48760019214	1	23.	0.9	24.	0.7	25.	0.8	26.	0.5		
FS48760019001	2	001	1	.3	26.	69				20.	0.
FS48760019201	2	.3	4.6	.4	5.2	.425	5.3	.45	9.1	.475	11.1
FS48760019202	2	.5	12.6	.525	20.5	.55	26.1	.6	23.6	.625	21.5
FS48760019203	2	.65	18.6	.675	12.8	.7	31.3	.725	49.4	.75	53.4
FS48760019204	2	.8	53.3	.9	53.1	1.	52.9	1.075	52.8	1.1	52.6
FS48760019205	2	1.2	51.7	1.3	50.8	1.4	46.9	1.45	41.5	1.5	42.6
FS48760019206	2	1.55	43.8	1.6	43.9	1.65	43.9	1.7	42.2	1.725	41.4
FS48760019207	2	1.8	42.4	1.85	43.0	1.9	37.3	1.925	30.4	2.	34.4
FS48760019208	2	2.2	27.2	2.5	16.3	3.	1.7	3.5	1.7	4.	4.5
FS48760019209	2	4.5	8.1	5.	8.2	5.5	6.8	6.	2.3	6.5	1.0
FS48760019210	2	7.	1.7	7.5	1.5	8.	1.8	8.5	1.9	9.	3.6
FS48760019211	2	9.5	5.2	10.	4.6	10.5	3.8	11.	3.1	12.	3.2
FS48760019212	2	13.	3.2	14.	4.3	15.	3.6	16.	3.0	17.	2.4
FS48760019213	2	18.	2.0	19.	1.5	20.	1.2	21.	1.2	22.	0.7
FS48760019214	2	23.	1.2	24.	0.8	25.	1.7	26.	1.2		

APPENDIX P

SPECTRAL SCIENCES INC.
GREEN ASPEN LEAF,
BOTTOM OF LEAF F
FS4877:

INDEX TO APPENDIX P

PAGE NO.

DIRECTIONAL REFLECTANCE

APPENDIX P

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APPENDIX P

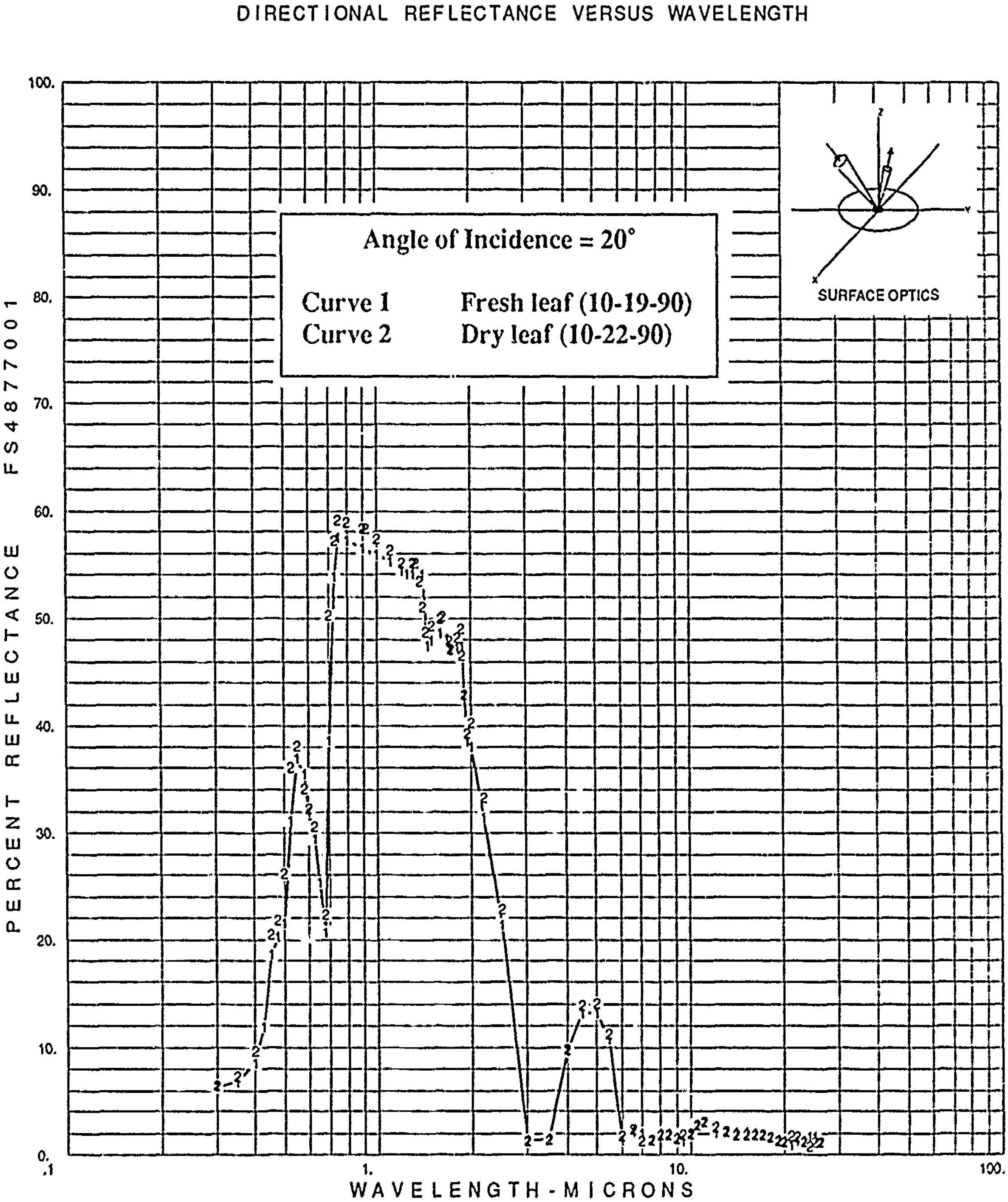

FIGURE P-1. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
BOTTOM OF LEAF F.
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 26.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX P

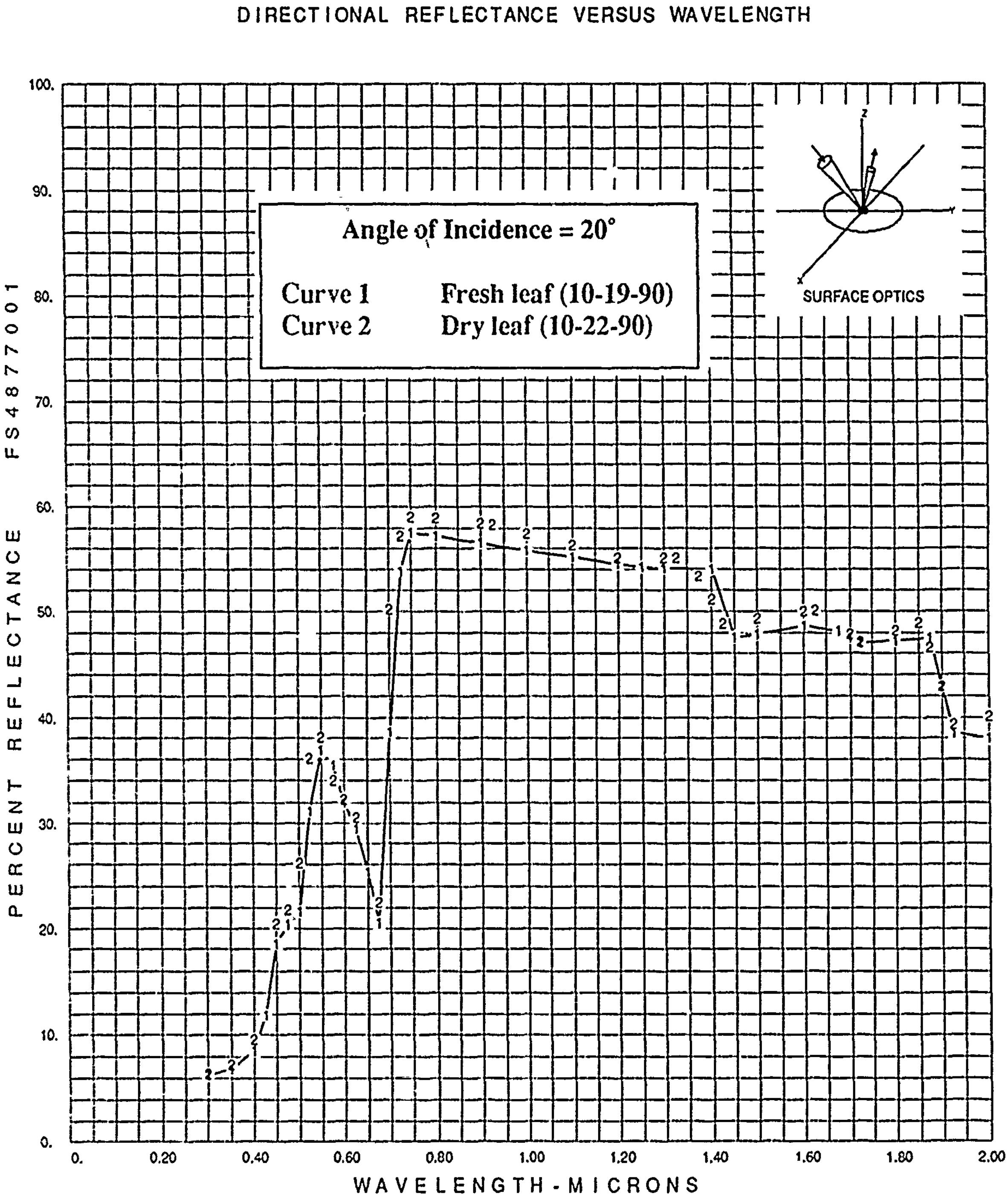

FIGURE P-2. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
BOTTOM OF LEAF F.
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 2.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX P

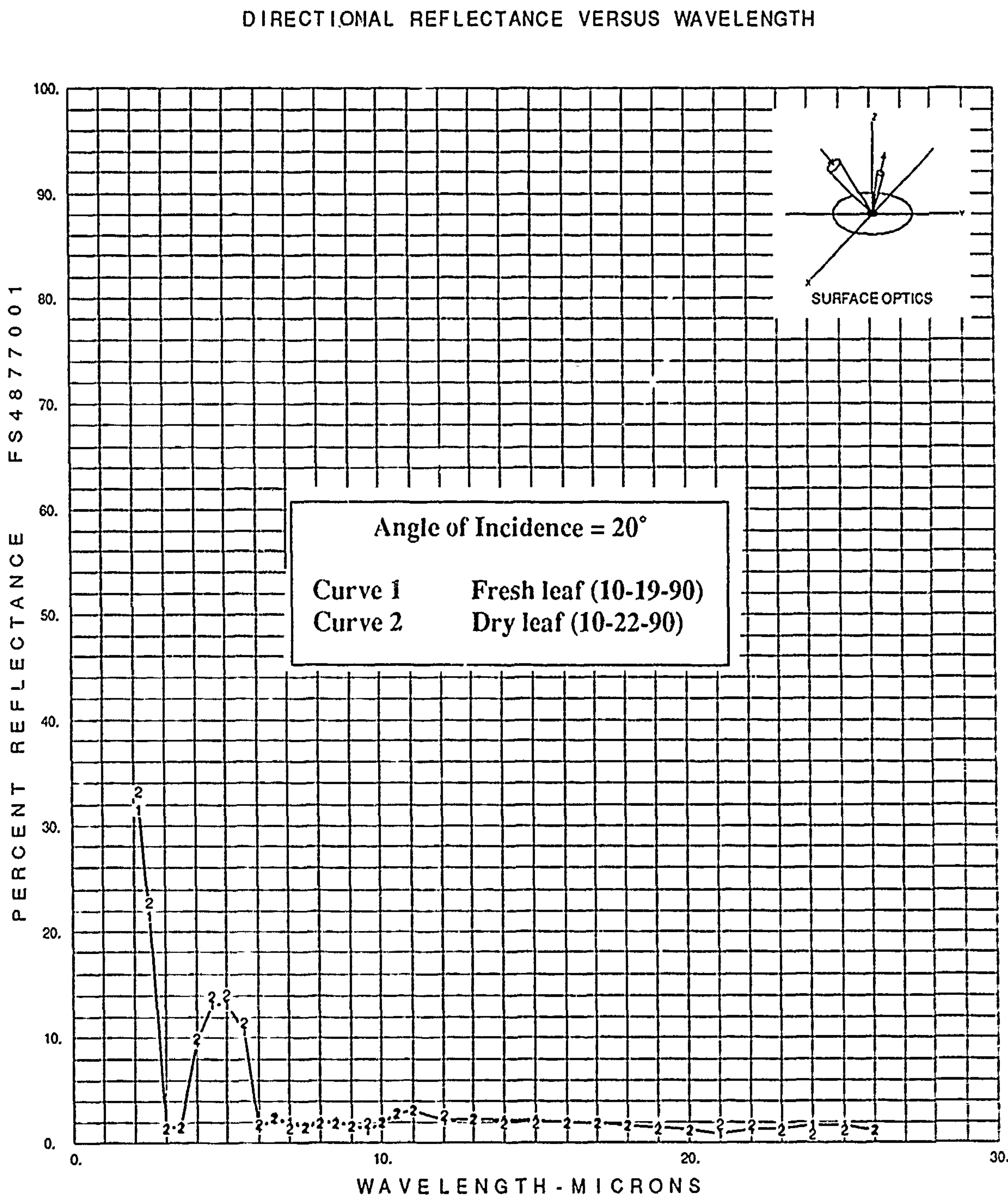

FIGURE P-3. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
BOTTOM OF LEAF F.
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 2.2 TO 26.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX P

TABLE P-1. SPECTRAL SCIENCES: GREEN ASPEN LEAF. BOTTOM OF LEAF F. DIRECTIONAL REFLECTANCE VS. WAVELENGTH - ERAS DATA DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION CURVE 1 - FRESH LEAF, CURVE 2 - DRY LEAF

```
FS48770015001        2      1
FS48770015101      SPECTRAL SCIENCES: GREEN ASPEN LEAF. BOTTOM OF LEAF F.
FS48770015102      Curve 1 measured on 10-19-90, Curve 2 measured on 10-22-90
FS48770015103      UNCORRECTED FOR INSTRUMENTATION POLARIZATION EFFECTS
FS48770017001      101990 and 102290
FS48770019001   1      001  1     .3    26.   70                      20.     0.
FS48770019201   1      .3   6.3   .35   6.8   .4    8.6  .425  11.9   .45   18.6
FS48770019202   1    .475  20.3    .5  21.5  .525  31.2   .55  36.9  .575   35.5
FS48770019203   1      .6  32.0  .625  29.4   .65  25.4  .675  20.6    .7   38.6
FS48770019204   1    .725  53.8   .75  57.5    .8  57.2    .9  56.5    1.   55.9
FS48770019205   1     1.1  55.2   1.2  54.5  1.25  54.2   1.3  54.1   1.4   54.0
FS48770019206   1    1.45  47.5   1.5  47.9   1.6  48.6 1.675  48.1   1.7   47.5
FS48770019207   1   1.725  47.0   1.8  47.2 1.875  47.4   1.9  42.9 1.925   38.5
FS48770019208   1      2.  38.0   2.2  31.4   2.5  21.4    3.   1.5   3.5    1.6
FS48770019209   1      4.   9.6   4.5  13.2    5.  13.2   5.5  10.7    6.    1.5
FS48770019210   1     6.5   2.2    7.   2.0   7.5   1.5    8.   2.0   8.5    2.0
FS48770019211   1      9.   1.7   9.5   1.3   10.   1.9  10.5   2.8   11.    3.1
FS48770019212   1     12.   2.1   13.   2.2   14.   2.1   15.   2.1   16.    2.0
FS48770019213   1     17.   1.9   18.   1.7   19.   1.5   20.   1.3   21.    0.9
FS48770019214   1     22.   1.3   23.   1.4   24.   1.7   25.   1.7   26.    1.2
FS48770019001   2      001  1     .3    26.   71                      20.     0.
FS48770019201   2      .3   6.4   .35   7.3    .4   9.6   .45  20.4  .475   21.8
FS48770019202   2      .5  26.1  .525  36.1   .55  38.1  .575  34.1    .6   32.3
FS48770019203   2    .625  30.5  .675  22.4    .7  50.3  .725  57.2   .75   59.1
FS48770019204   2      .8  58.9    .9  58.4  .925  58.3    1.  57.4   1.1   56.3
FS48770019205   2     1.2  55.1   1.3  55.1 1.325  55.1 1.375  53.4   1.4   51.1
FS48770019206   2   1.425  48.8   1.5  49.3   1.6  50.0 1.625  50.2   1.7   47.9
FS48770019207   2   1.725  47.1   1.8  48.2  1.85  49.0 1.875  46.6   1.9   42.9
FS48770019208   2   1.925  39.3    2.  40.2   2.2  33.3   2.5  22.8    3.    1.4
FS48770019209   2     3.5   1.5    4.   9.9   4.5  13.9    5.  14.1   5.5   11.3
FS48770019210   2      6.   1.8   6.5   2.4    7.   1.4   7.5   1.5    8.    1.9
FS48770019211   2     8.5   1.9    9.   1.6   9.5   1.9   10.   2.0  10.5    2.8
FS48770019212   2     11.   3.1   12.   2.6   13.   2.2   14.   1.9   15.    1.9
FS48770019213   2     16.   1.9   17.   1.9   18.   1.7   19.   1.3   20.    1.2
FS48770019214   2     21.   1.8   22.   1.7   23.   1.2   24.   0.8   25.    1.2
FS48770019215   2     26.   1.2
```

APPENDIX Q

SPECTRAL SCIENCES INC.
GREEN ASPEN LEAF,
TOP OF LEAF G
FS4878:

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DIRECTIONAL REFLECTANCE

APPENDIX Q

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APPENDIX Q

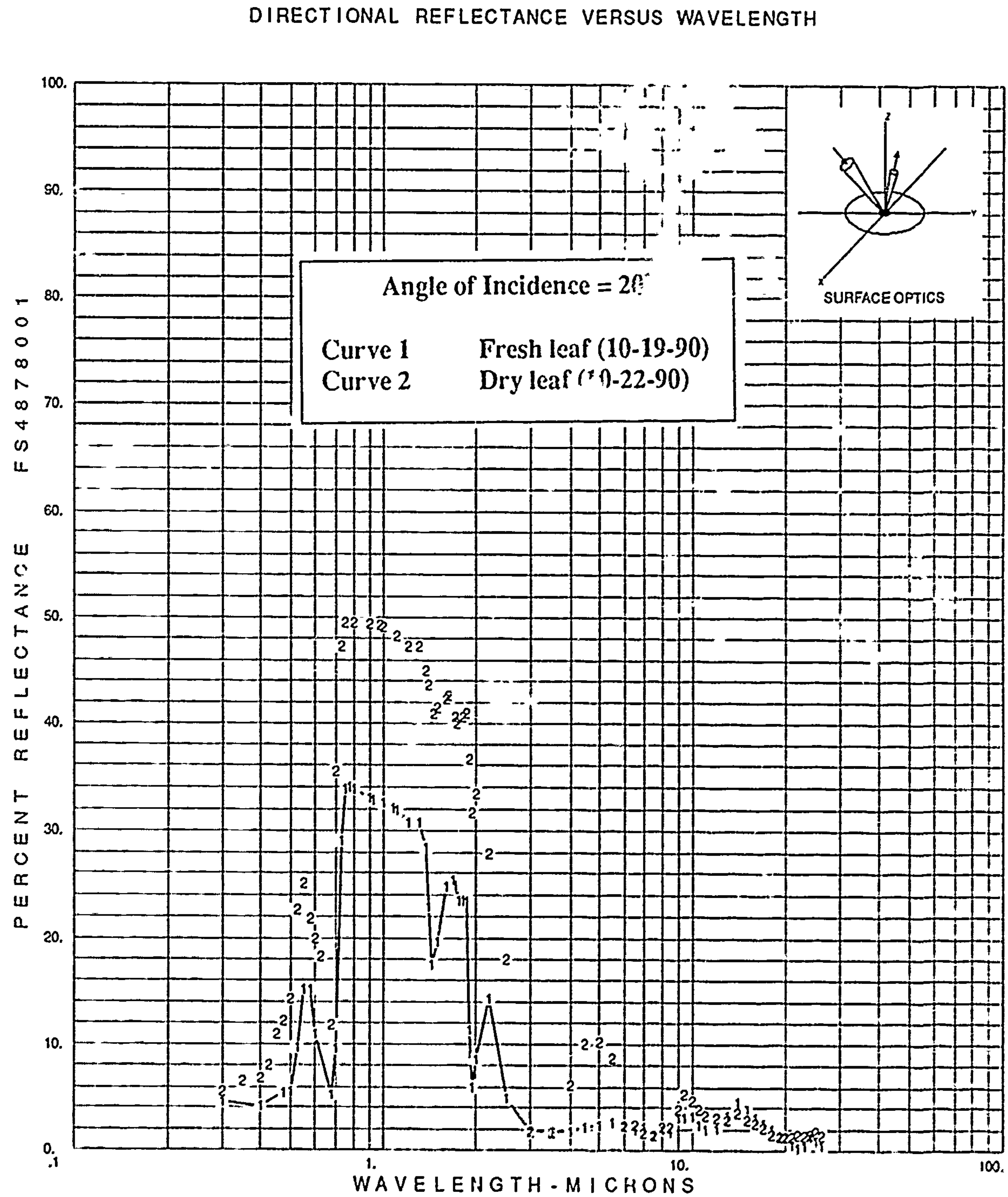

FIGURE Q-1. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
TOP OF LEAF G
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 26.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

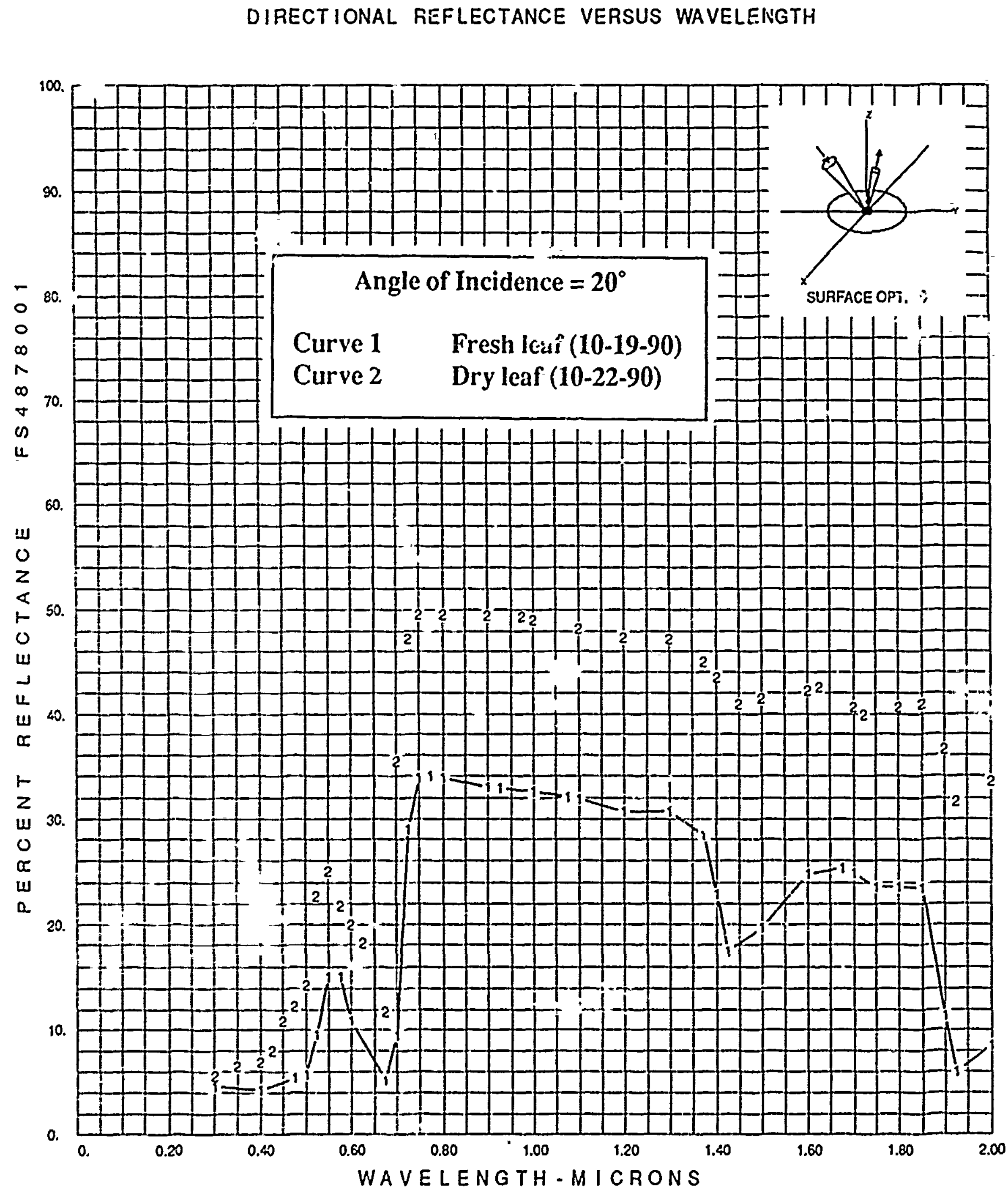

FIGURE Q-2. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
TOP OF LEAF G
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 2.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX Q

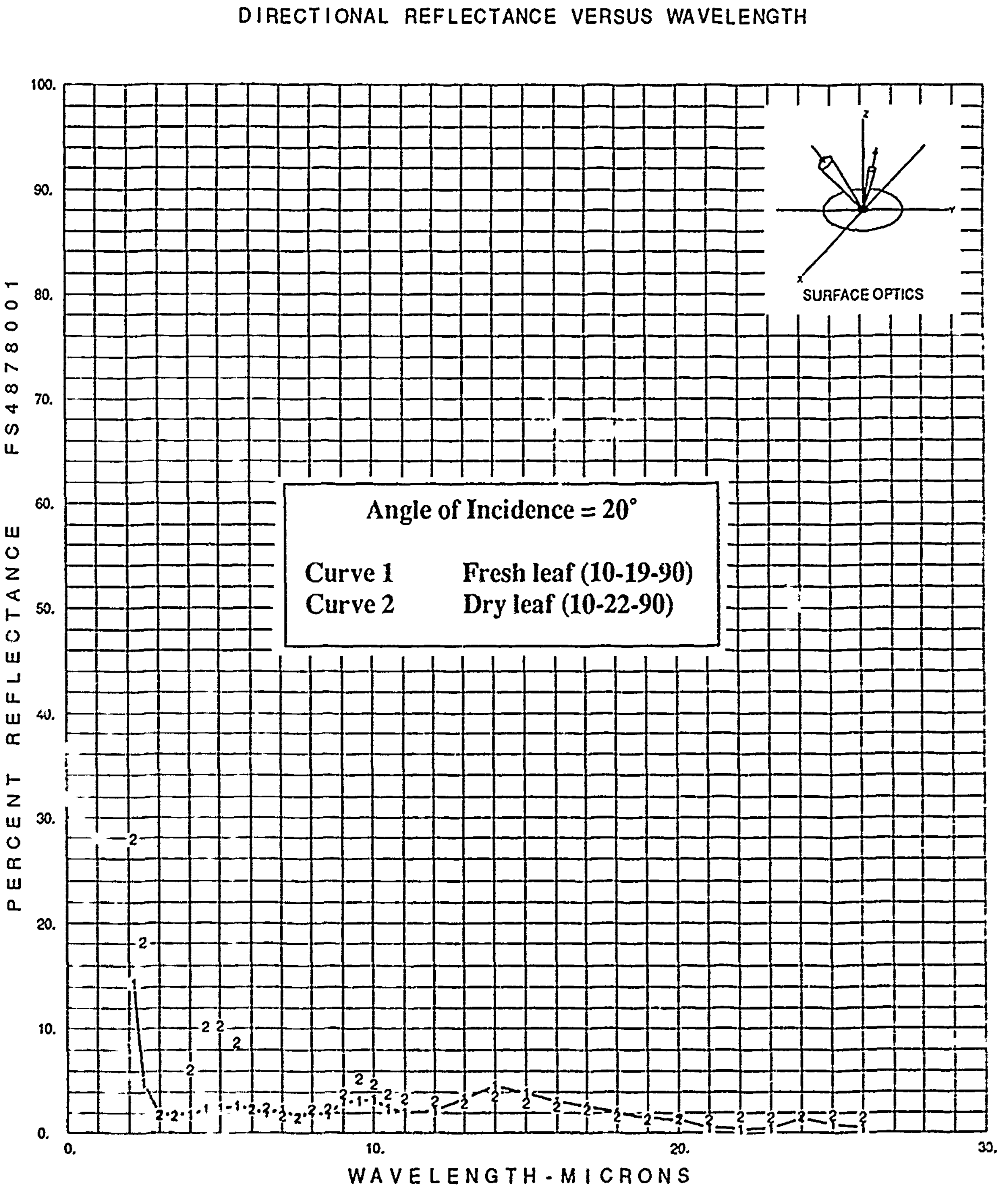

FIGURE Q-3. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
TOP OF LEAF G
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 2.2 TO 26.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX Q

TABLE Q-1. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
TOP OF LEAF G
DIRECTIONAL REFLECTANCE VS. WAVELENGTH - ERAS DATA
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION
CURVE 1 - FRESH LEAF, CURVE 2 - DRY LEAF

FS48780015001		2	1								
FS48780015101		SPECTRAL SCIENCES: GREEN ASPEN LEAF. TOP OF LEAF G									
FS48780015102		Cur 1 measured on 10-19-90, Curve 2 measured on 10-22-90									
FS48780015103		UNCO..ECTED FOR INSTRUMENTATION POLARIZATION EFFECTS									
FS48780017001		101990 and 102290									
FS48780019001	1	001	1	.3	26.	68				20.	0.
FS48780019201	1	.3	4.6	.4	4.2	.475	5.4	.5	5.6	.525	9.6
FS48780019202	1	.55	15.1	.575	15.1	.6	10.9	.675	5.2	.7	9.5
FS48780019203	1	.725	29.0	.75	33.8	.775	34.0	.8	33.8	.9	33.0
FS48780019204	1	.925	32.8	1.	32.5	1.075	32.1	1.1	31.8	1.2	30.7
FS48780019205	1	1.3	30.7	1.375	28.4	1.4	22.9	1.425	17.5	1.5	19.7
FS48780019206	1	1.6	24.7	1.675	25.4	1.7	24.8	1.75	23.5	1.8	23.5
FS48780019207	1	1.85	23.4	1.9	11.4	1.925	6.0	2.	8.6	2.2	14.3
FS48780019208	1	2.5	4.9	3.	1.8	3.5	1.8	4.	1.8	4.5	2.2
FS48780019209	1	5.	2.4	5.5	2.6	6.	2.3	6.5	2.0	7.	2.2
FS48780019210	1	7.5	1.5	8.	2.0	8.5	1.8	9.	3.1	9.5	3.1
FS48780019211	1	10.	3.2	10.5	2.4	11.	2.0	12.	2.1	13.	3.3
FS48780019212	1	14.	4.6	15.	3.9	16.	3.1	17.	2.6	18.	2.0
FS48780019213	1	19.	1.5	20.	1.3	21.	0.6	22.	0.4	23.	0.5
FS48780019214	1	24.	1.4	25.	0.9	26.	0.5				
FS48780019001	2	001	1	.3	26.	70				20.	0.
FS48780019201	2	.3	5.5	.35	6.5	.4	6.8	.425	8.0	.45	10.9
FS48780019202	2	.475	12.2	.5	14.3	.525	22.6	.55	25.0	.575	21.8
FS48780019203	2	.6	20.0	.625	18.3	.675	11.8	.7	35.5	.725	47.2
FS48780019204	2	.75	49.5	.8	49.5	.9	49.4	.975	49.3	1.	49.1
FS48780019205	2	1.1	48.2	1.2	47.3	1.3	47.2	1.375	45.0	1.4	43.6
FS48780019206	2	1.45	40.9	1.5	41.4	1.6	42.3	1.625	42.5	1.7	40.6
FS48780019207	2	1.725	40.0	1.8	40.6	1.85	41.0	1.9	36.7	1.925	31.6
FS48780019208	2	2.	33.5	2.2	27.9	2.5	18.1	3.	1.8	3.5	1.7
FS48780019209	2	4.	6.1	4.5	10.1	5.	10.3	5.5	8.7	6.	2.3
FS48780019210	2	6.5	2.4	7.	1.7	7.5	1.5	8.	2.2	8.5	2.2
FS48780019211	2	9.	3.8	9.5	5.3	10.	4.7	10.5	3.8	11.	3.3
FS48780019212	2	12.	3.1	13.	2.9	14.	3.6	15.	2.9	16.	2.6
FS48780019213	2	17.	2.2	18.	1.6	19.	1.3	20.	1.4	21.	1.3
FS48780019214	2	22.	1.6	23.	1.5	24.	1.6	25.	1.8	26.	1.5

APPENDIX R

SPECTRAL SCIENCES INC.
GREEN ASPEN LEAF,
BOTTOM OF LEAF G
FS4879:

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APPENDIX R

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APPENDIX R

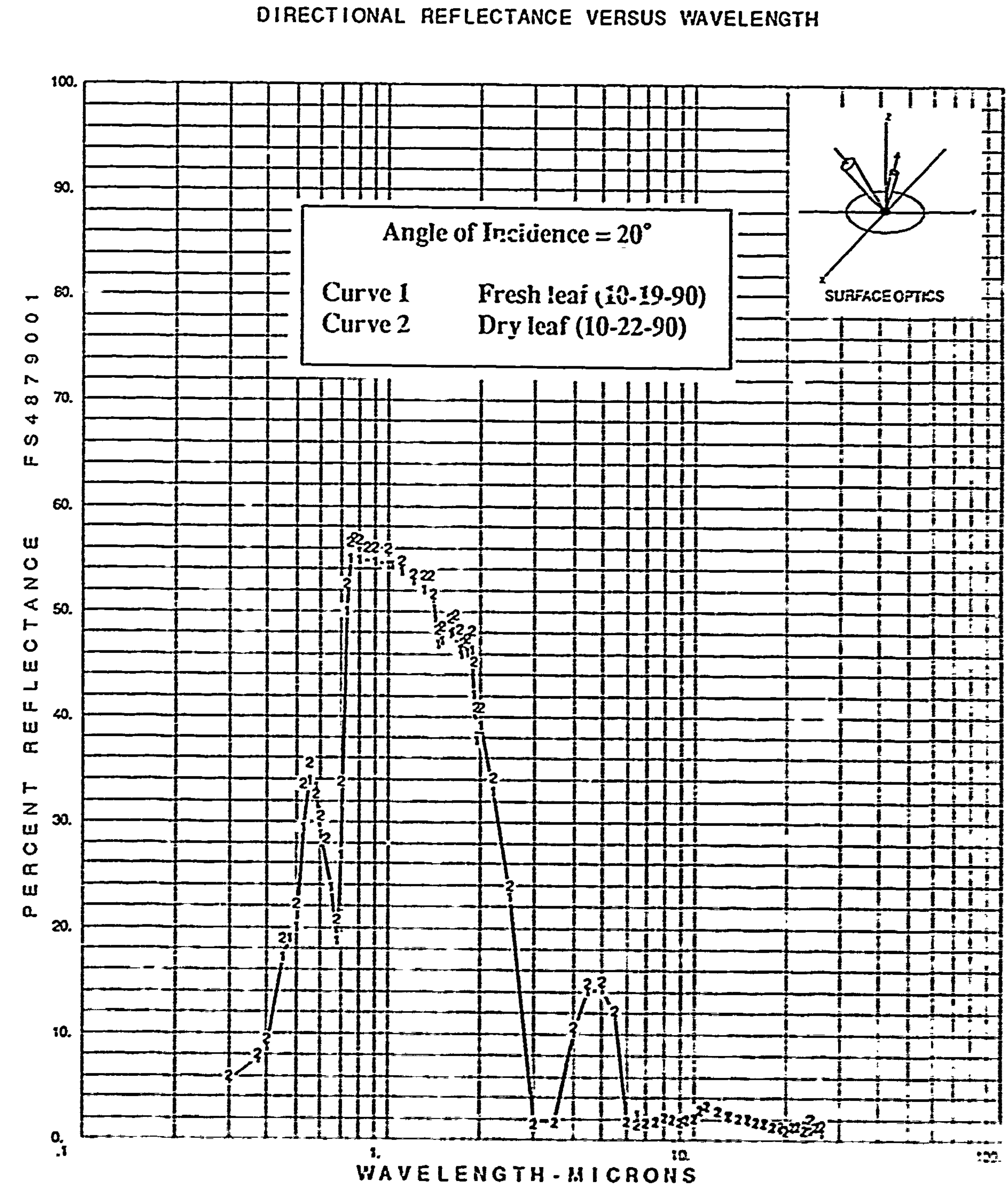

FIGURE R-1. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
BOTTOM OF LEAF G
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 25.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX R

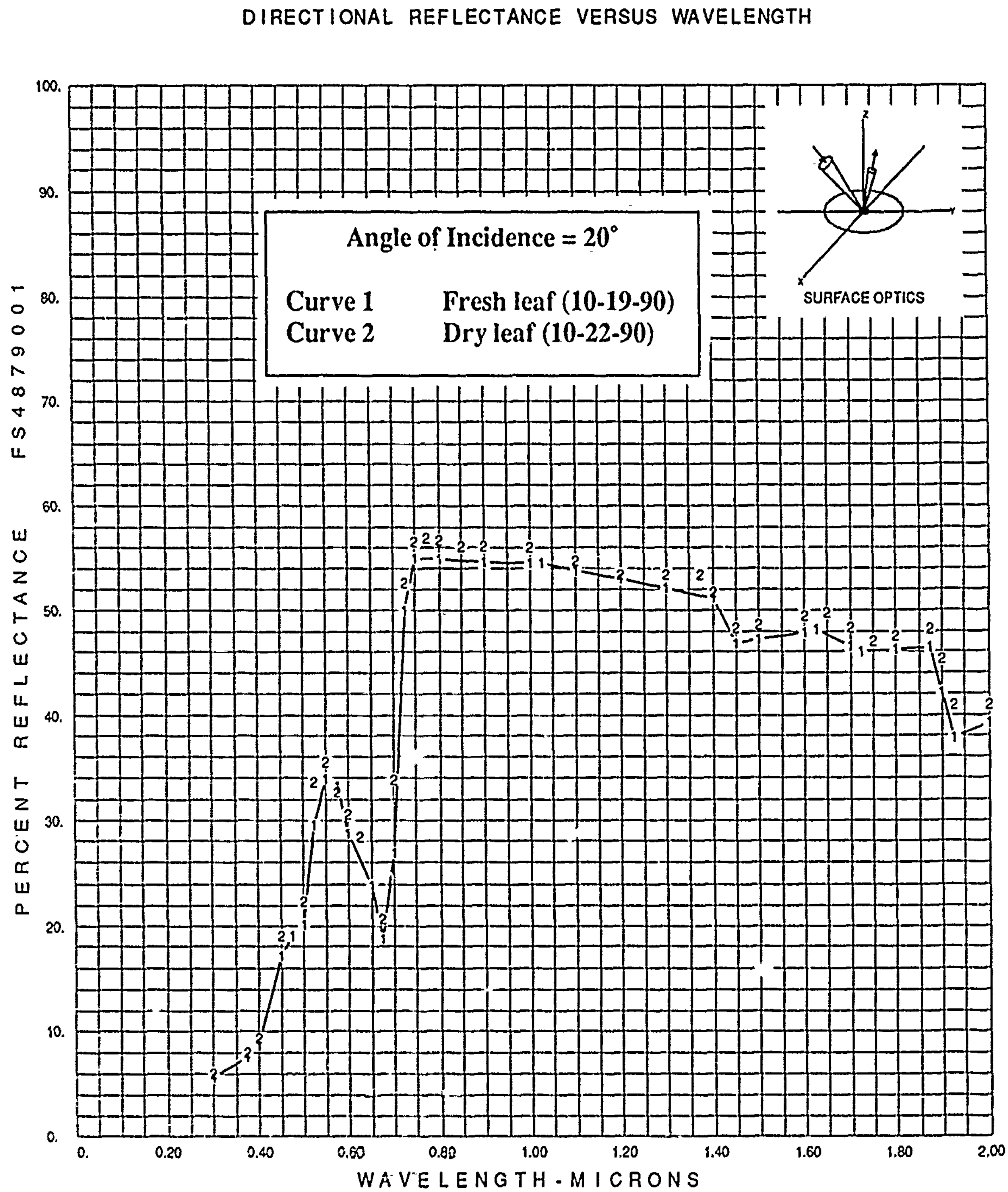

FIGURE R-2. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
BOTTOM OF LEAF G
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 2.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX R

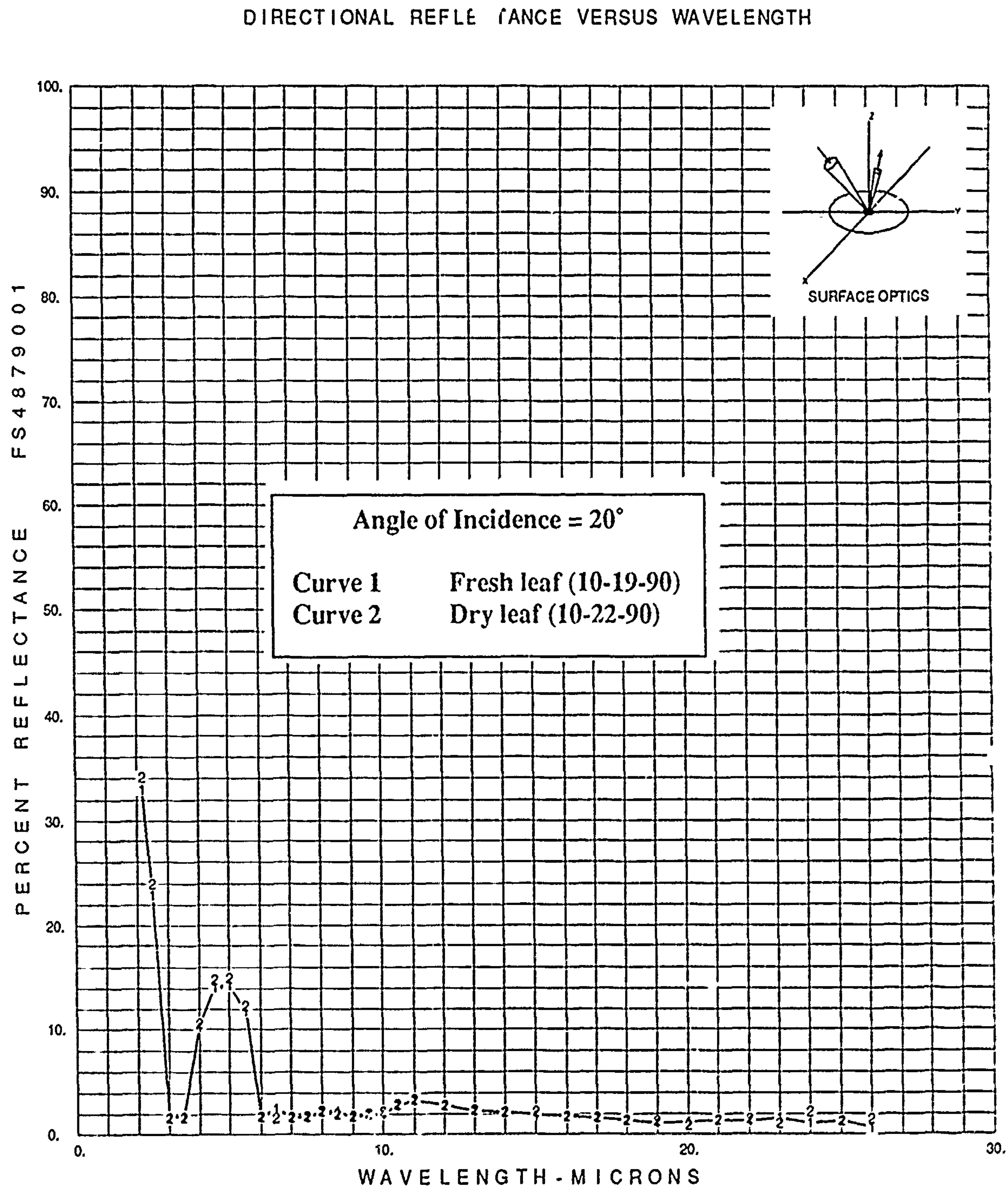

FIGURE R-3. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
BOTTOM OF LEAF G
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 2.2 TO 26.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX R

TABLE R-1. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
BOTTOM OF LEAF G
DIRECTIONAL REFLECTANCE VS. WAVELENGTH - ERAS DATA
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION
CURVE 1 - FRESH LEAF, CURVE 2 - DRY LEAF

FS48790015001		2	1								
FS48790015101		SPECTRAL SCIENCES: GREEN ASPEN LEAF. BOTTOM OF LEAF G									
FS48790015102		Curve 1 measured on 10-19-90, Curve 2 measured on 10-22-90									
FS48790015103		UNCORRECTED FOR INSTRUMENTATION POLARIZATION EFFECTS									
FS48790017001		101990 and 102290									
FS48790019001	1	001	1	.3	26.	68				20.	0.
FS48790019201	1	.3	5.7	.375	7.6	.4	8.7	.45	17.2	.475	19.0
FS48790019202	1	.5	20.1	.525	29.5	.55	33.9	.575	33.3	.6	28.8
FS48790019203	1	.65	23.8	.675	18.8	.7	26.9	.725	50.1	.75	55.0
FS48790019204	1	.8	54.9	.9	54.7	1.	54.5	1.025	54.5	1.1	53.8
FS48790019205	1	1.2	53.0	1.3	52.1	1.4	51.2	1.45	46.9	1.5	47.2
FS48790019206	1	1.6	47.9	1.625	48.1	1.7	46.5	1.725	46.0	1.8	46.2
FS48790019207	1	1.875	46.4	1.9	42.2	1.925	37.9	2.	39.2	2.2	32.9
FS48790019208	1	2.5	22.9	3.	1.7	3.5	1.8	4.	10.2	4.5	14.1
FS48790019209	1	5.	14.3	5.5	11.8	6.	1.8	6.5	2.5	7.	1.7
FS48790019210	1	7.5	1.7	8.	2.1	8.5	2.1	9.	1.7	9.5	1.9
FS48790019211	1	10.	2.0	10.5	2.8	11.	3.2	12.	2.8	13.	2.2
FS48790019212	1	14.	2.1	15.	1.9	16.	1.8	17.	1.6	18.	1.4
FS48790019213	1	19.	1.0	20.	1.1	21.	1.4	22.	1.3	23.	1.6
FS48790019214	1	24.	1.0	25.	1.3	26.	0.7				
FS48790019001	2	001	1	.3	26.	69				20.	0.
FS48790019201	2	.3	6.0	.375	8.0	.4	9.4	.45	19.0	.5	22.3
FS48790019202	2	.525	33.6	.55	35.6	.575	32.6	.6	30.5	.625	28.4
FS48790019203	2	.675	20.7	.7	33.8	.725	52.6	.75	56.6	.775	57.0
FS48790019204	2	.8	56.7	.85	56.1	.9	56.1	1.	56.0	1.1	54.8
FS48790019205	2	1.2	53.5	1.3	53.4	1.375	53.4	1.4	51.7	1.45	48.3
FS48790019206	2	1.5	48.6	1.6	49.4	1.65	49.7	1.7	48.3	1.75	47.0
FS48790019207	2	1.8	47.5	1.875	48.2	1.9	45.3	1.925	41.0	2.	40.9
FS48790019208	2	2.2	34.2	2.5	24.0	3.	1.6	3.5	1.7	4.	10.6
FS48790019209	2	4.5	14.8	5.	15.0	5.5	12.2	6.	1.8	6.5	1.6
FS48790019210	2	7.	1.7	7.5	1.8	8.	2.2	8.5	2.0	9.	1.8
FS48790019211	2	9.5	2.0	10.	2.1	10.5	2.9	11.	3.3	12.	2.8
FS48790019212	2	13.	2.4	14.	2.1	15.	2.1	16.	1.8	17.	1.7
FS48790019213	2	18.	1.4	19.	1.3	20.	0.9	21.	1.4	22.	1.5
FS48790019214	2	23.	1.0	24.	2.1	25.	1.3	26.	1.5		

APPENDIX S

SPECTRAL SCIENCES INC.
GREEN ASPEN LEAF,
TOP OF LEAF H
FS4880:

INDEX TO APPENDIX S

PAGE NO.

DIRECTIONAL REFLECTANCE

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APPENDIX S

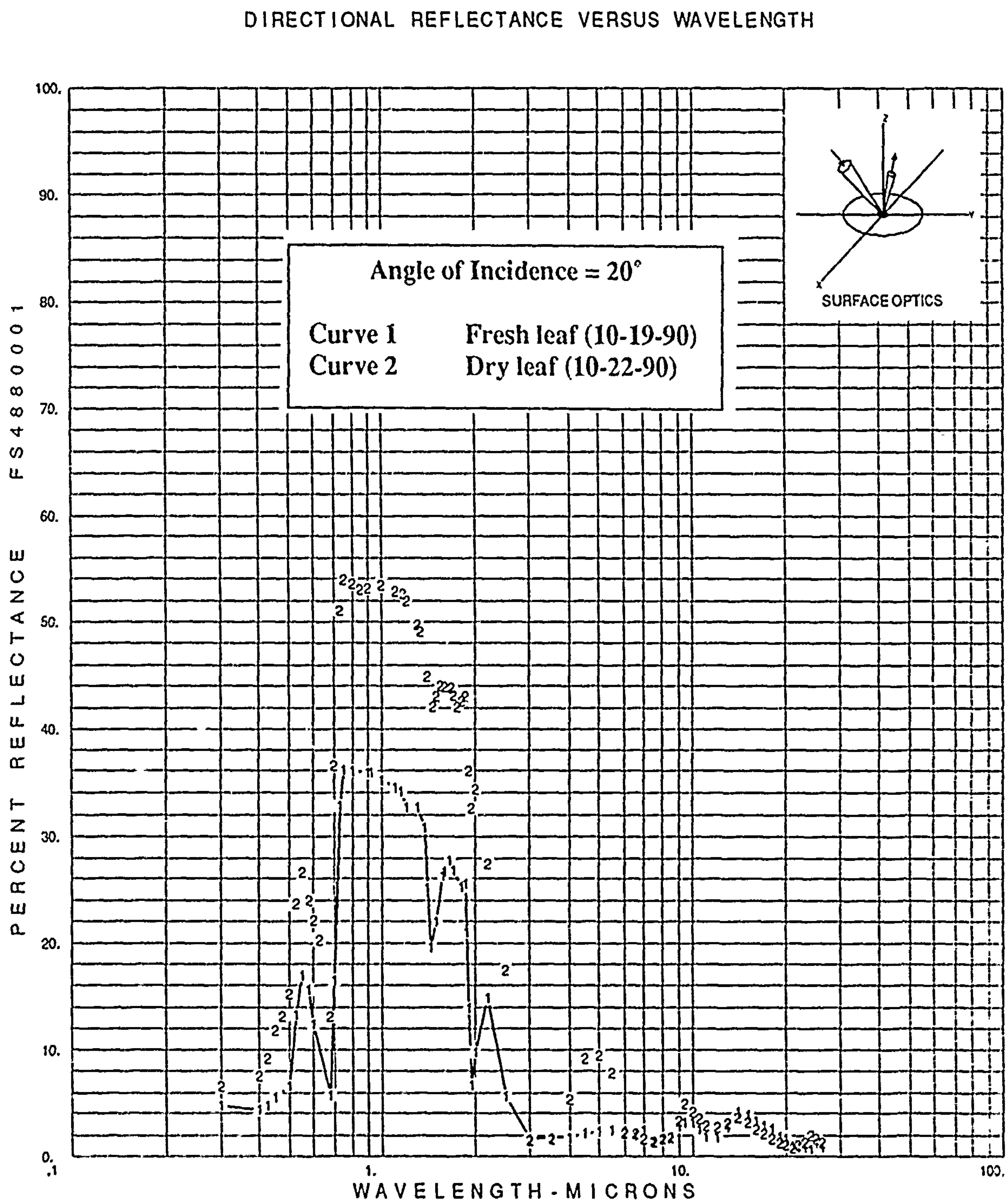

FIGURE S-1. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
TOP OF LEAF H
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 26.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX S

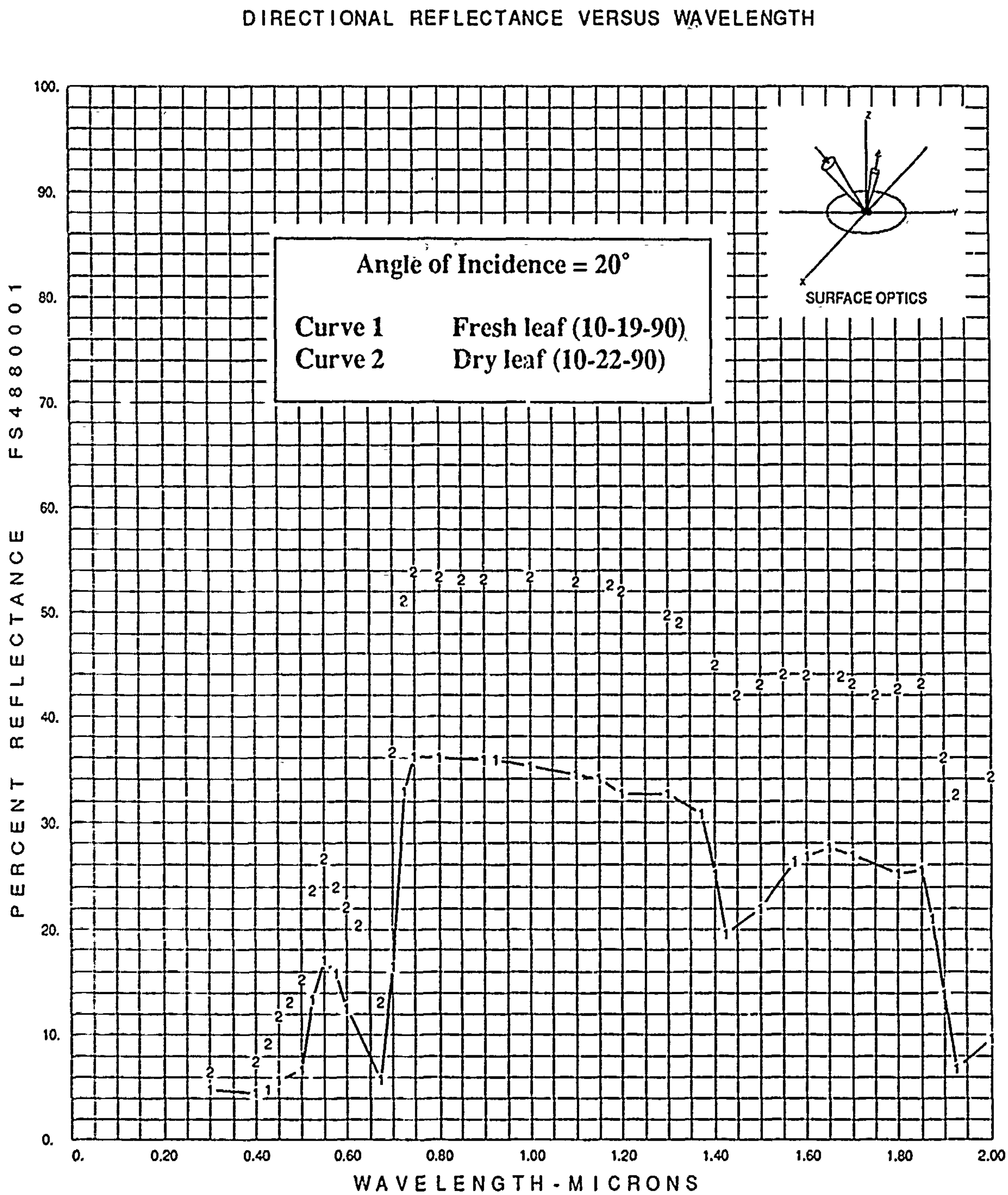

FIGURE S-2. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
TOP OF LEAF H
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 2.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX S

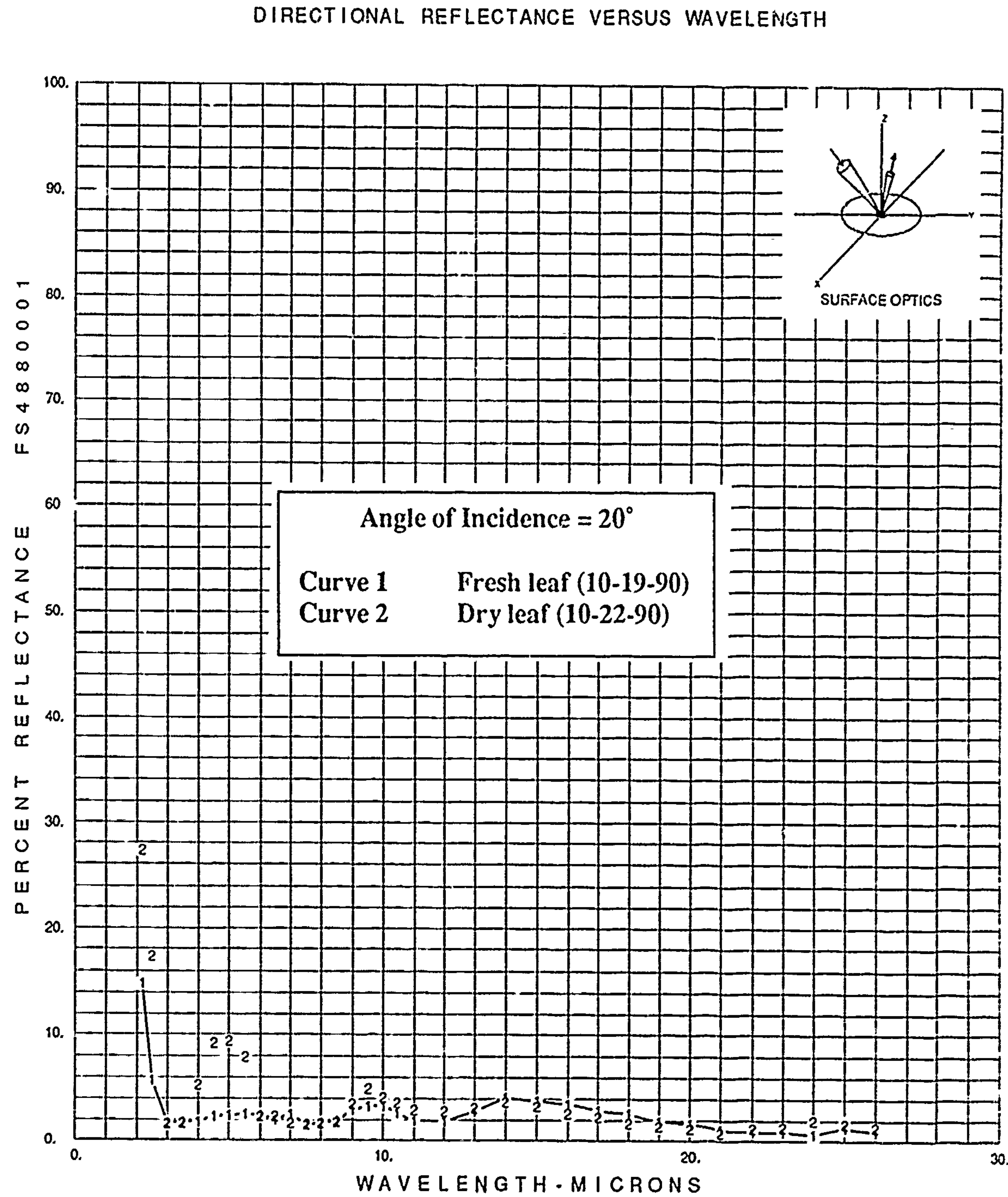

FIGURE S-3. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
TOP OF LEAF H
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 2.2 TO 26.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX S

TABLE S-1. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
TOP OF LEAF H
DIRECTIONAL REFLECTANCE VS. WAVELENGTH - ERAS DATA
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION
CURVE 1 - FRESH LEAF, CURVE 2 - DRY LEAF

FS48800015001		2	1								
FS48800015101		SPECTRAL SCIENCES: GREEN ASPEN LEAF. TOP OF LEAF H									
FS48800015102		Curve 1 measured on 10-19-90, Curve 2 measured on 10-22-90									
FS48800015103		UNCORRECTED FOR INSTRUMENTATION POLARIZATION EFFECTS									
FS48800017001		101990 and 102290									
FS48800019001	1	001	1	.3	26.	69				20.	0.
FS48800019201	1	.3	4.8	.4	4.4	.425	4.8	.45	5.6	.5	6.6
FS48800019202	1	.525	13.3	.55	17.0	.575	15.7	.6	12.4	.675	5.8
FS48800019203	1	.7	16.5	.725	32.8	.75	36.1	.8	36.0	.9	35.8
FS48800019204	1	.925	35.8	1.	35.2	1.1	34.5	1.15	34.1	1.2	32.6
FS48800019205	1	1.3	32.6	1.375	30.8	1.4	25.2	1.425	19.6	1.5	22.0
FS48800019206	1	1.575	26.4	1.6	26.8	1.65	27.7	1.7	26.9	1.8	25.3
FS48800019207	1	1.85	25.6	1.875	21.0	1.9	13.9	1.925	6.7	2.	9.7
FS48800019208	1	2.2	14.8	2.5	5.7	3.	1.7	3.5	1.8	4.	1.8
FS48800019209	1	4.5	2.2	5.	2.4	5.5	2.5	6.	2.4	6.5	2.0
FS48800019210	1	7.	2.5	7.5	1.5	8.	1.7	8.5	1.9	9.	2.9
FS48800019211	1	9.5	3.2	10.	3.2	10.5	2.6	11.	1.9	12.	1.9
FS48800019212	1	13.	2.8	14.	4.1	15.	3.8	16.	3.4	17.	2.9
FS48800019213	1	18.	2.6	19.	1.9	20.	1.7	21.	1.0	22.	0.9
FS48800019214	1	23.	0.9	24.	0.7	25.	1.3	26.	0.9		
FS48800019001	2	001	1	.3	26.	71				20.	0.
FS48800019201	2	.3	6.5	.4	7.5	.425	9.2	.45	11.8	.475	13.1
FS48800019202	2	.5	15.3	.525	23.6	.55	26.7	.575	24.0	.6	22.1
FS48800019203	2	.625	20.3	.675	13.1	.7	36.6	.725	51.1	.75	53.9
FS48800019204	2	.8	53.5	.85	53.1	.9	53.2	1.	53.4	1.1	52.9
FS48800019205	2	1.175	52.6	1.2	52.0	1.3	49.7	1.325	49.1	1.4	44.9
FS48800019206	2	1.45	42.1	1.5	43.0	1.55	44.0	1.6	43.9	1.675	43.8
FS48800019207	2	1.7	43.2	1.75	42.1	1.8	42.6	1.85	43.1	1.9	36.0
FS48800019208	2	1.925	32.5	2.	34.3	2.2	27.4	2.5	17.4	3.	1.6
FS48800019209	2	3.5	1.7	4.	5.3	4.5	9.2	5.	9.4	5.5	7.8
FS48800019210	2	6.	2.2	6.5	2.2	7.	1.7	7.5	1.5	8.	1.7
FS48800019211	2	8.5	1.8	9.	3.4	9.5	4.9	10.	4.1	10.5	3.6
FS48800019212	2	11.	2.9	12.	2.8	13.	3.1	14.	3.7	15.	3.2
FS48800019213	2	16.	2.6	17.	2.2	18.	1.7	19.	1.4	20.	1.1
FS48800019214	2	21.	0.8	22.	1.1	23.	1.3	24.	2.0	25.	1.7
FS48800019215	2	26.	1.3								

APPENDIX T

SPECTRAL SCIENCES INC.
GREEN ASPEN LEAF,
BOTTOM OF LEAF H
FS4881:

INDEX TO APPENDIX T

PAGE NO.

DIRECTIONAL REFLECTANCE

APPENDIX T

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APPENDIX T

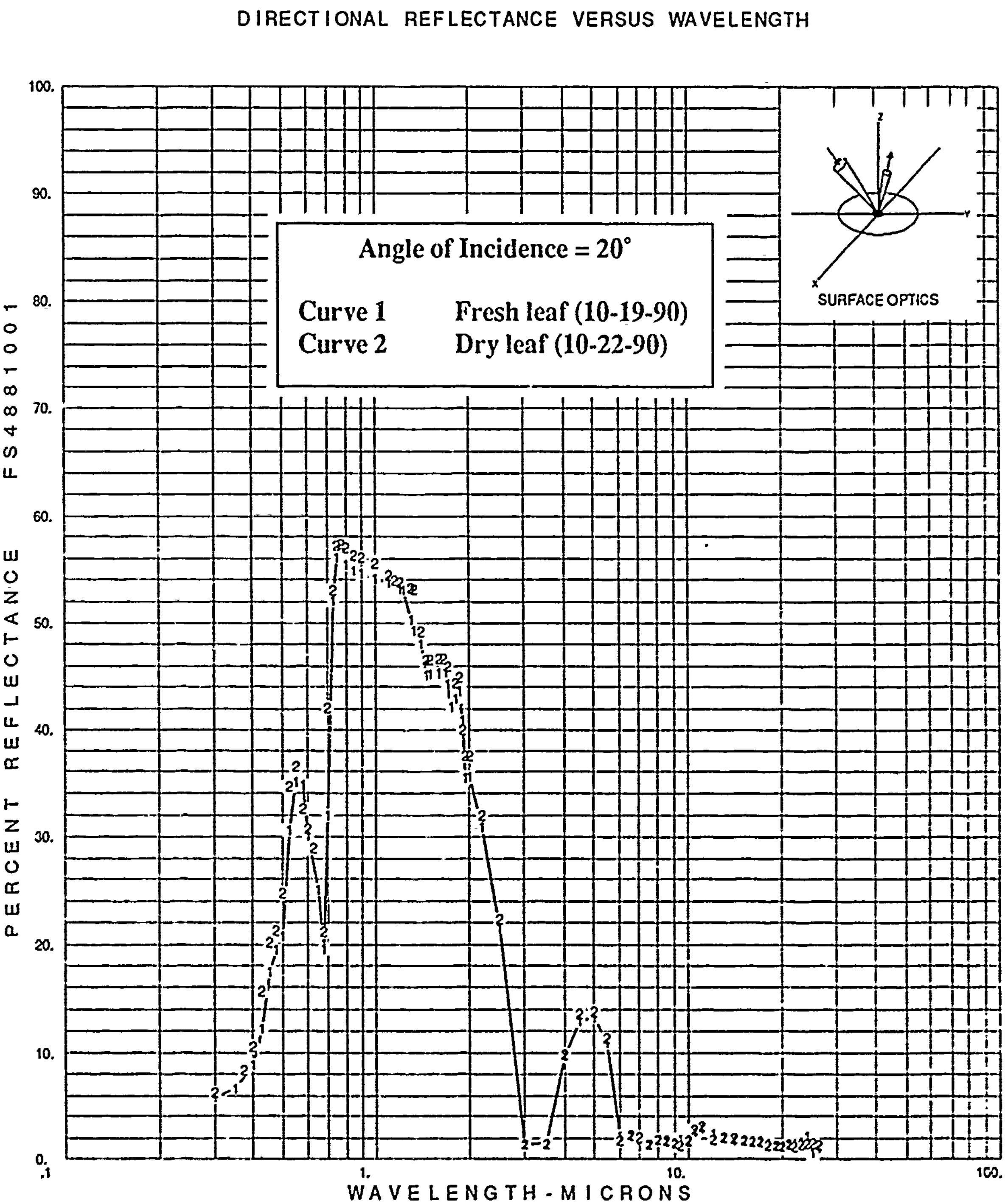

FIGURE T-1. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
BOTTOM OF LEAF H
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 26.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX T

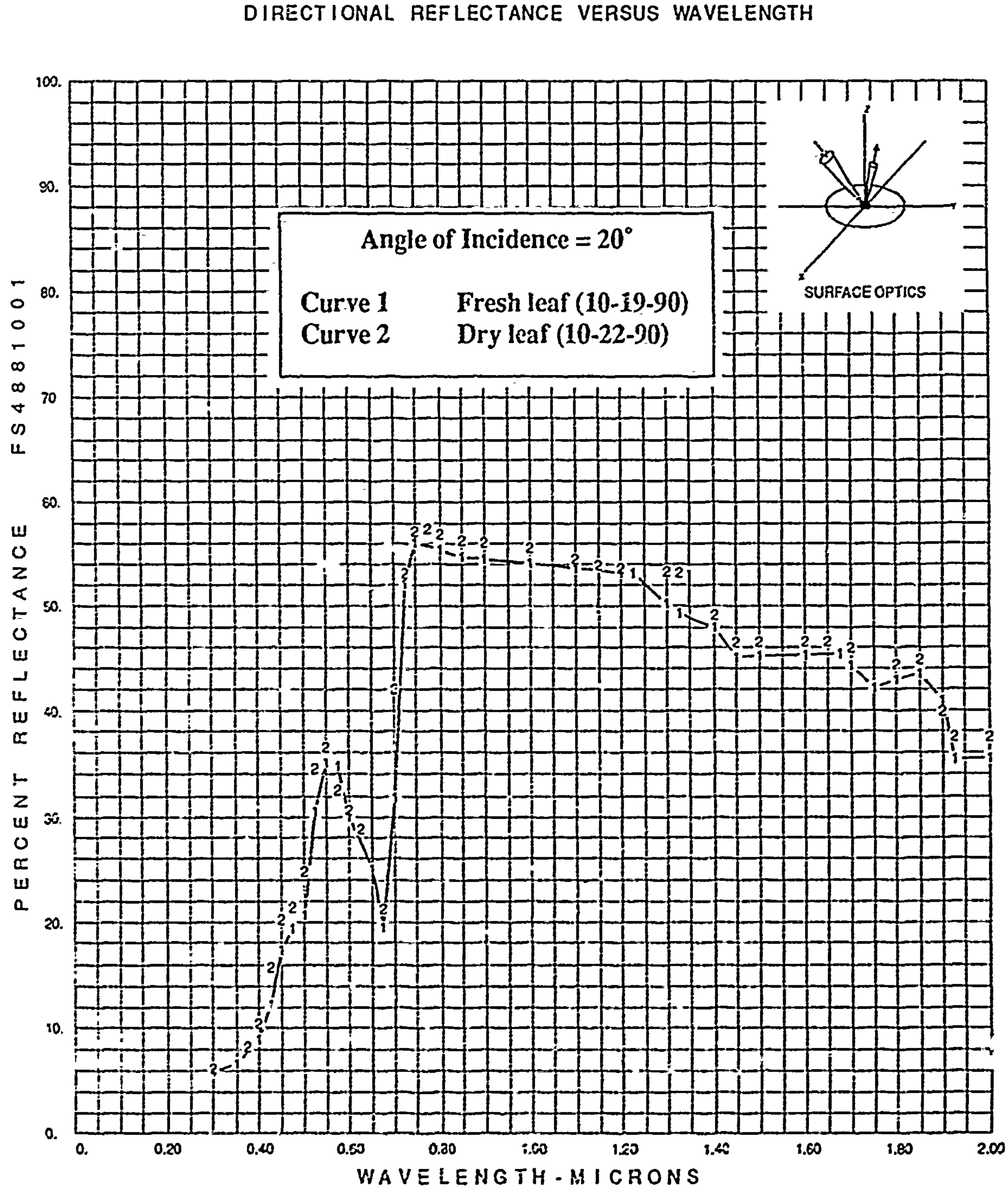

FIGURE T-2. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
BOTTOM OF LEAF H
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 2.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX T

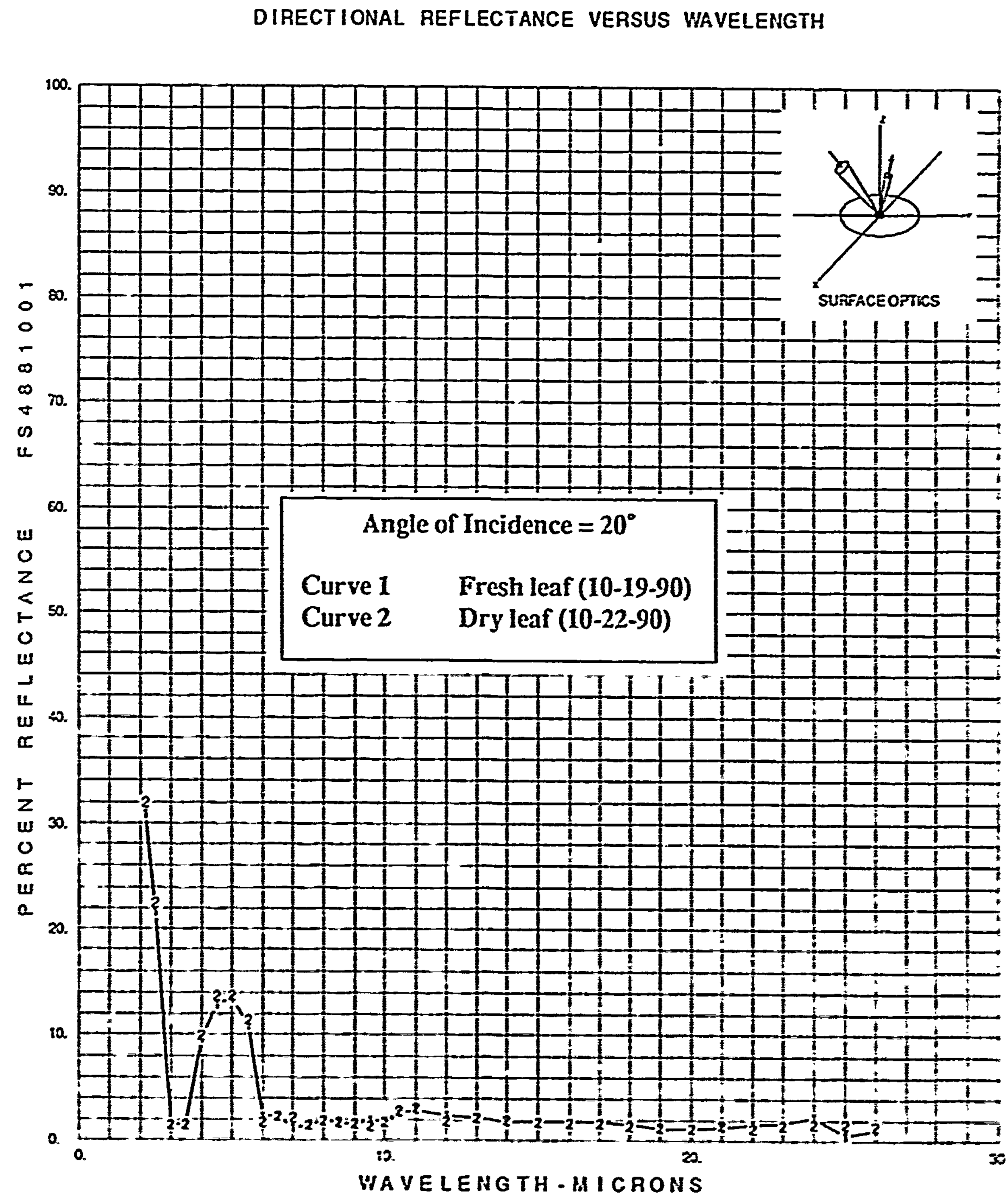

FIGURE T-3. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
BOTTOM OF LEAF H
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 2.2 TO 26.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX T

TABLE T-1. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
BOTTOM OF LEAF H
DIRECTIONAL REFLECTANCE VS. WAVELENGTH - ERAS DATA
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION
CURVE 1 - FRESH LEAF, CURVE 2 - DRY LEAF

FS48810015001		2	1								
FS48810015101		SPECTRAL SCIENCES: GREEN ASPEN LEAF. BOTTOM OF LEAF H									
FS48810015102		Curve 1 measured on 10-19-90, Curve 2 measured on 10-22-90									
FS48810015103		UNCORRECTED FOR INSTRUMENTATION POLARIZATION EFFECTS									
FS48810017001		101990 and 102290									
FS48810019001	1	001	1	.3	26.	71				20.	0.
FS48810019201	1	.3	5.9	.35	6.6	.4	8.9	.425	12.2	.45	17.4
FS48810019202	1	.475	19.4	.5	20.7	.525	30.5	.55	35.1	.575	34.7
FS48810019203	1	.6	30.1	.65	25.1	.675	19.6	.7	31.9	.725	52.1
FS48810019204	1	.75	56.1	.8	55.4	.85	54.8	.9	54.6	1.	54.1
FS48810019205	1	1.1	53.7	1.2	53.2	1.225	53.1	1.3	50.3	1.325	49.3
FS48810019206	1	1.4	48.0	1.45	45.1	1.5	45.2	1.6	45.3	1.675	45.4
FS48810019207	1	1.7	44.3	1.75	42.2	1.8	42.9	1.85	43.6	1.9	40.9
FS48810019208	1	1.925	35.5	2.	35.6	2.2	30.9	2.5	21.5	3.	1.5
FS48810019209	1	3.5	1.6	4.	9.6	4.5	12.9	5.	13.3	5.5	10.9
FS48810019210	1	6.	2.2	6.5	2.2	7.	1.2	7.5	1.5	8.	1.9
FS48810019211	1	8.5	1.7	9.	1.6	9.5	1.9	10.	1.9	10.5	2.6
FS48810019212	1	11.	2.9	12.	2.4	13.	2.1	14.	1.8	15.	1.8
FS48810019213	1	16.	1.8	17.	1.8	18.	1.6	19.	1.2	20.	1.1
FS48810019214	1	21.	1.3	22.	1.6	23.	1.7	24.	2.2	25.	0.6
FS48810019215	1	26.	1.0								
FS48810019001	2	001	1	.3	26.	71				20.	0.
FS48810019201	2	.3	6.2	.375	8.3	.4	10.5	.425	15.7	.45	20.2
FS48810019202	2	.475	21.3	.5	24.7	.525	34.6	.55	36.6	.575	32.5
FS48810019203	2	.6	30.7	.625	28.9	.675	21.2	.7	42.1	.725	53.1
FS48810019204	2	.75	57.2	.775	57.4	.8	57.0	.85	56.3	.9	56.1
FS48810019205	2	1.	55.6	1.1	54.5	1.15	53.9	1.2	53.7	1.3	53.3
FS48810019206	2	1.325	53.2	1.4	49.2	1.45	46.6	1.5	46.6	1.6	46.7
FS48810019207	2	1.65	46.7	1.7	46.0	1.8	44.5	1.85	44.9	1.9	40.0
FS48810019208	2	1.925	37.5	2.	37.5	2.2	32.0	2.5	22.4	3.	1.5
FS48810019209	2	3.5	1.5	4.	9.9	4.5	13.6	5.	13.7	5.5	11.4
FS48810019210	2	6.	1.8	6.5	2.3	7.	2.1	7.5	1.5	8.	1.9
FS48810019211	2	8.5	1.8	9.	1.6	9.5	1.4	10.	1.8	10.5	2.8
FS48810019212	2	11.	3.1	12.	1.9	13.	2.1	14.	2.0	15.	1.8
FS48810019213	2	16.	1.7	17.	1.7	18.	1.4	19.	1.3	20.	1.2
FS48810019214	2	21.	1.5	22.	1.2	23.	1.5	24.	1.6	25.	1.6
FS48810019215	2	26.	1.4								

APPENDIX U

SPECTRAL SCIENCES INC.
GREEN ASPEN LEAF,
TRANSMITTANCE #1
FS4882:

INDEX TO APPENDIX U

APPENDIX U

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APPENDIX U

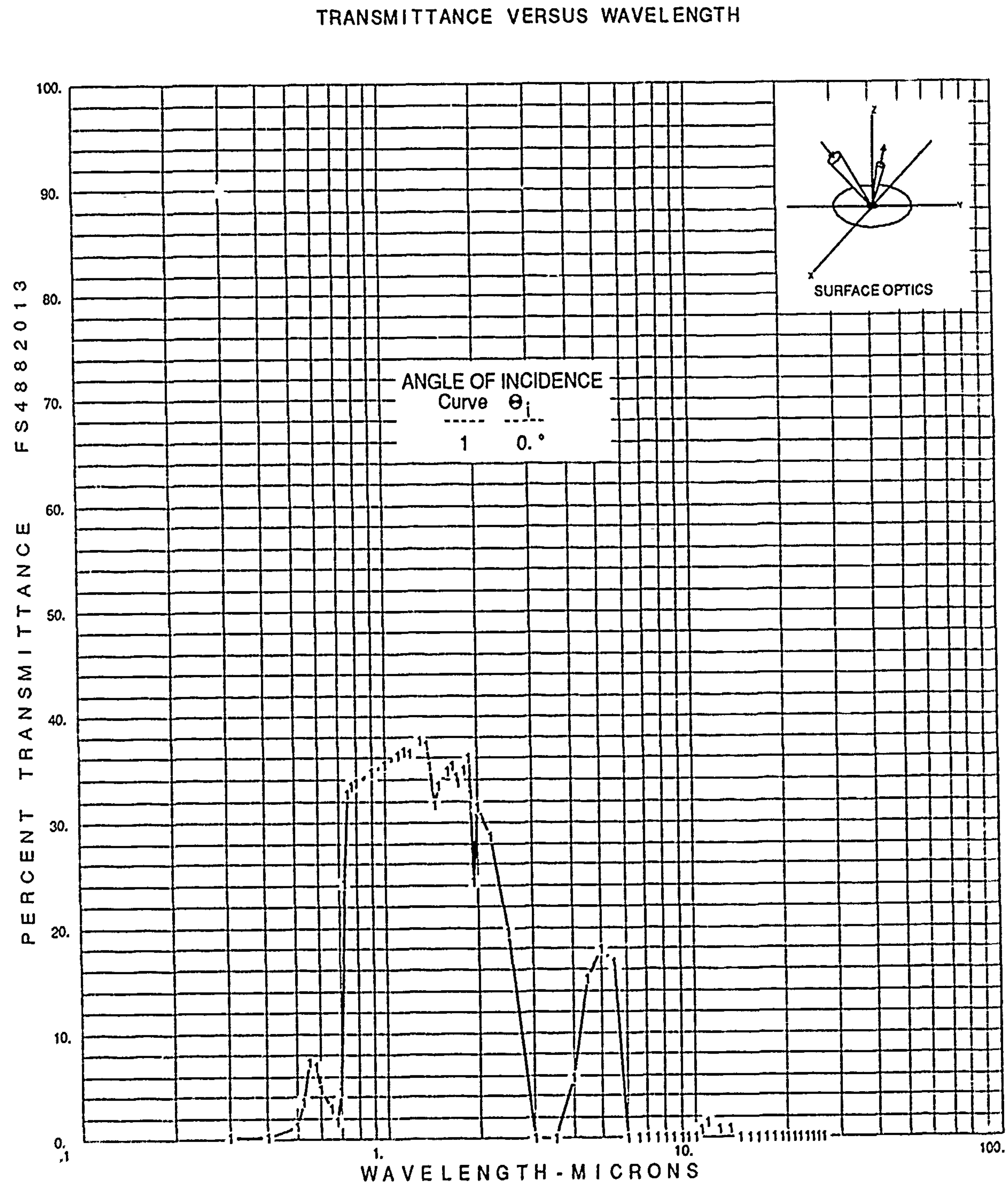

FIGURE U-1. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
TRANSMITTANCE SAMPLE #1
SCATTERED TRANSMITTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 26.0 MICROMETERS

APPENDIX U

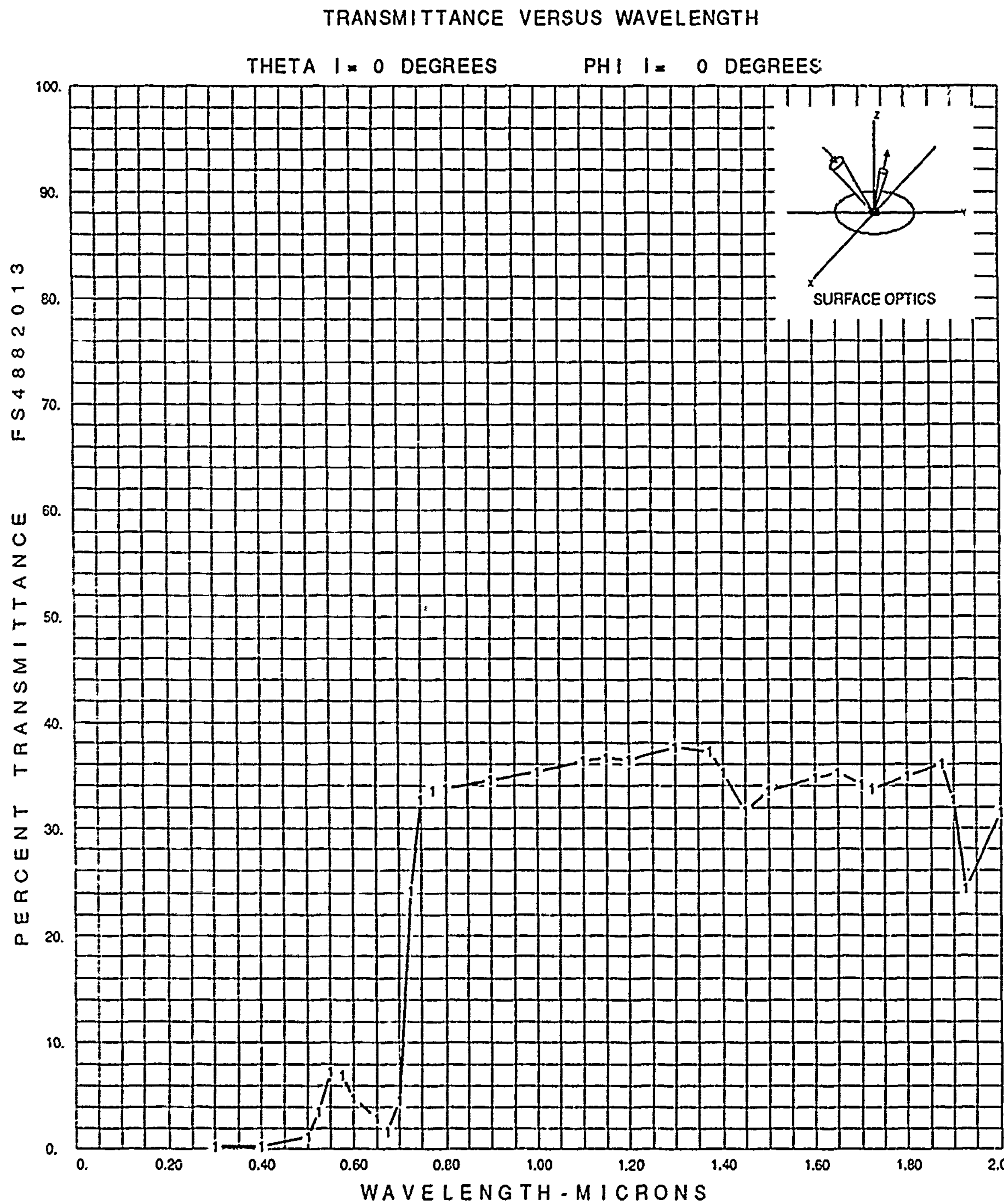

FIGURE U-2. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
TRANSMITTANCE SAMPLE #1
SCATTERED TRANSMITTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 2.0 MICROMETERS

APPENDIX U

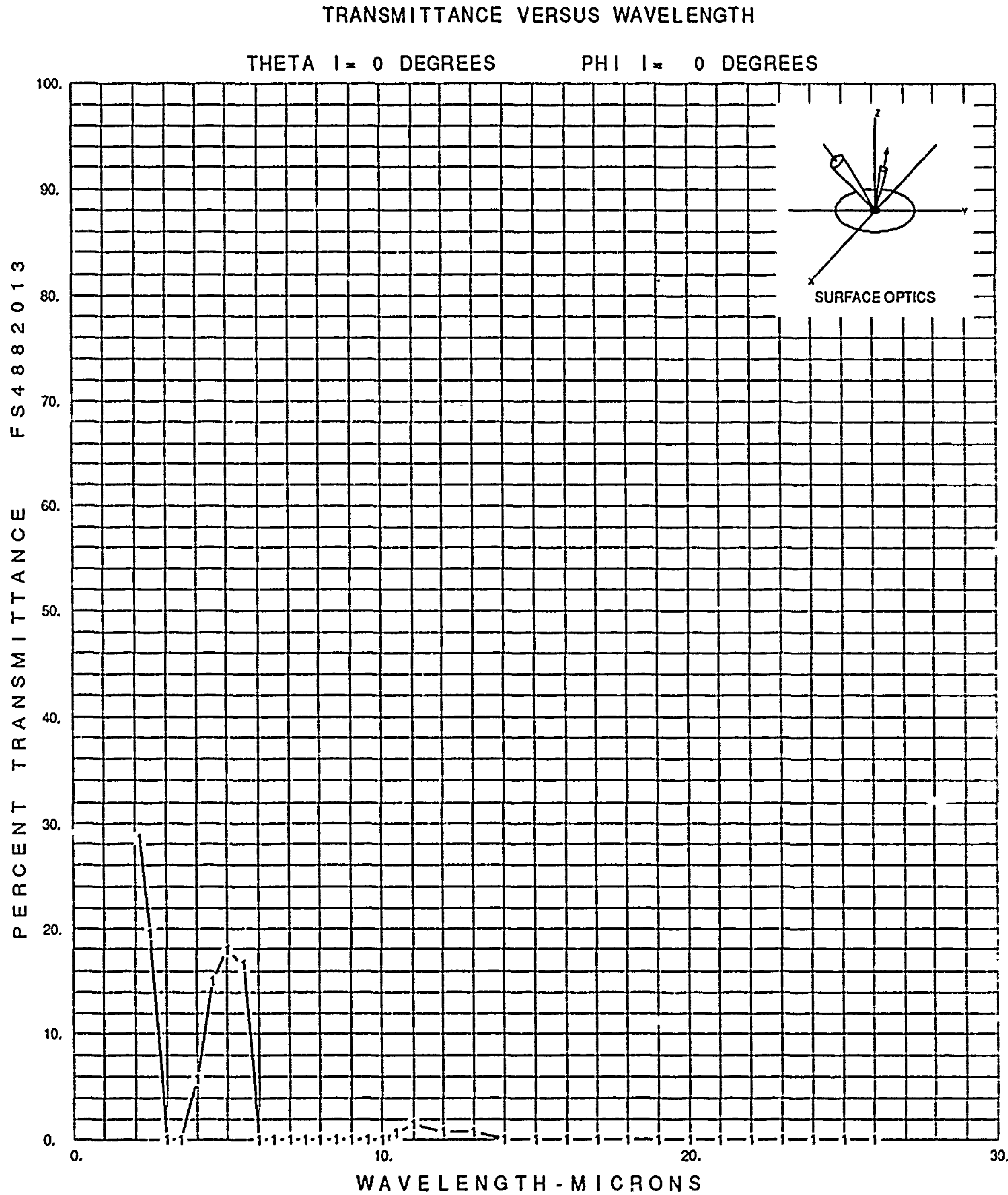

FIGURE U-3. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
TRANSMITTANCE SAMPLE #1
SCATTERED TRANSMITTANCE VS. WAVELENGTH
BANDWIDTH 2.2 TO 26.0 MICROMETERS

APPENDIX U

TABLE U-1. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
TRANSMITTANCE SAMPLE #1
SCATTERED TRANSMITTANCE VS. WAVELENGTH - ERAS DATA

```
FS48820135001          1     31
FS48820135101       SPECTRAL SCIENCES: GREEN ASPEN LEAF. TRANSMITTANCE SAMPLE #1
FS48820135102       SCATTERED TRANSMITTANCE
FS48820137001       102390
FS48820139001   1       001 31    .3   26.  67                           0.     0.
FS48820139201   1     .3   0.3    .4   0.3    .5   1.2  .525   3.6   .55    7.3
FS48820139202   1   .575   7.0    .6   4.8   .65   2.9  .675   1.7    .7    4.6
FS48820139203   1   .725  24.2   .75  32.6  .775  33.5    .8  33.7    .9   34.6
FS48820139204   1     1.  35.4   1.1  36.3  1.15  36.7   1.2  36.5   1.3   37.7
FS48820139205   1  1.375  37.2   1.4  35.3  1.45  31.6   1.5  33.5   1.6   34.7
FS48820139206   1   1.65  35.3   1.7  34.2 1.725  33.7   1.8  34.9 1.875   36.0
FS48820139207   1    1.9  32.6 1.925  24.4    2.  31.4   2.2  28.6   2.5   19.6
FS48820139208   1     3.   0.0   3.5   0.0    4.   5.8   4.5  15.1    5.   17.9
FS48820139209   1    5.5  16.6    6.   0.0   6.5   0.0    7.   0.0   7.5    0.0
FS48820139210   1     8.   0.0   8.5   0.0    9.   0.0   9.5   0.0   10.    0.0
FS48820139211   1   10.5   0.7   11.   1.5   12.   0.8   13.   0.8   14.    0.0
FS48820139212   1    15.   0.0   16.   0.0   17.   0.0   18.   0.0   19.    0.0
FS48820139213   1    20.   0.0   21.   0.0   22.   0.0   23.   0.0   24.    0.0
FS48820139214   1    25.   0.0   26.   0.0
```

APPENDIX V

SPECTRAL SCIENCES INC.
GREEN ASPEN LEAF,
TRANSMITTANCE #2
FS4883:

INDEX TO APPENDIX V

PAGE NO.

SCATTERED TRANSMITTANCE

APPENDIX V

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APPENDIX V

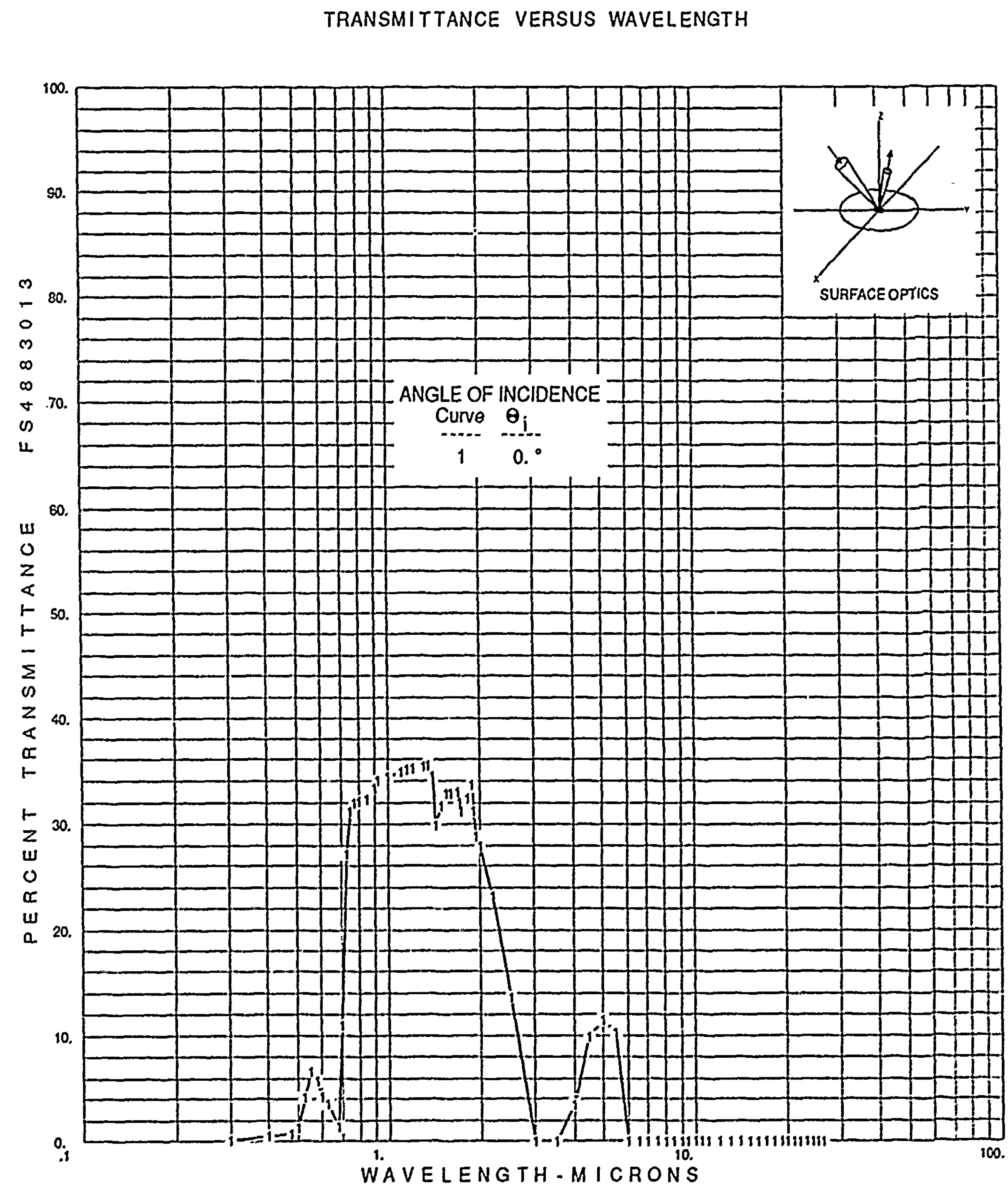

FIGURE V-1. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
TRANSMITTANCE SAMPLE #2
SCATTERED TRANSMITTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 26.0 MICROMETERS

APPENDIX V

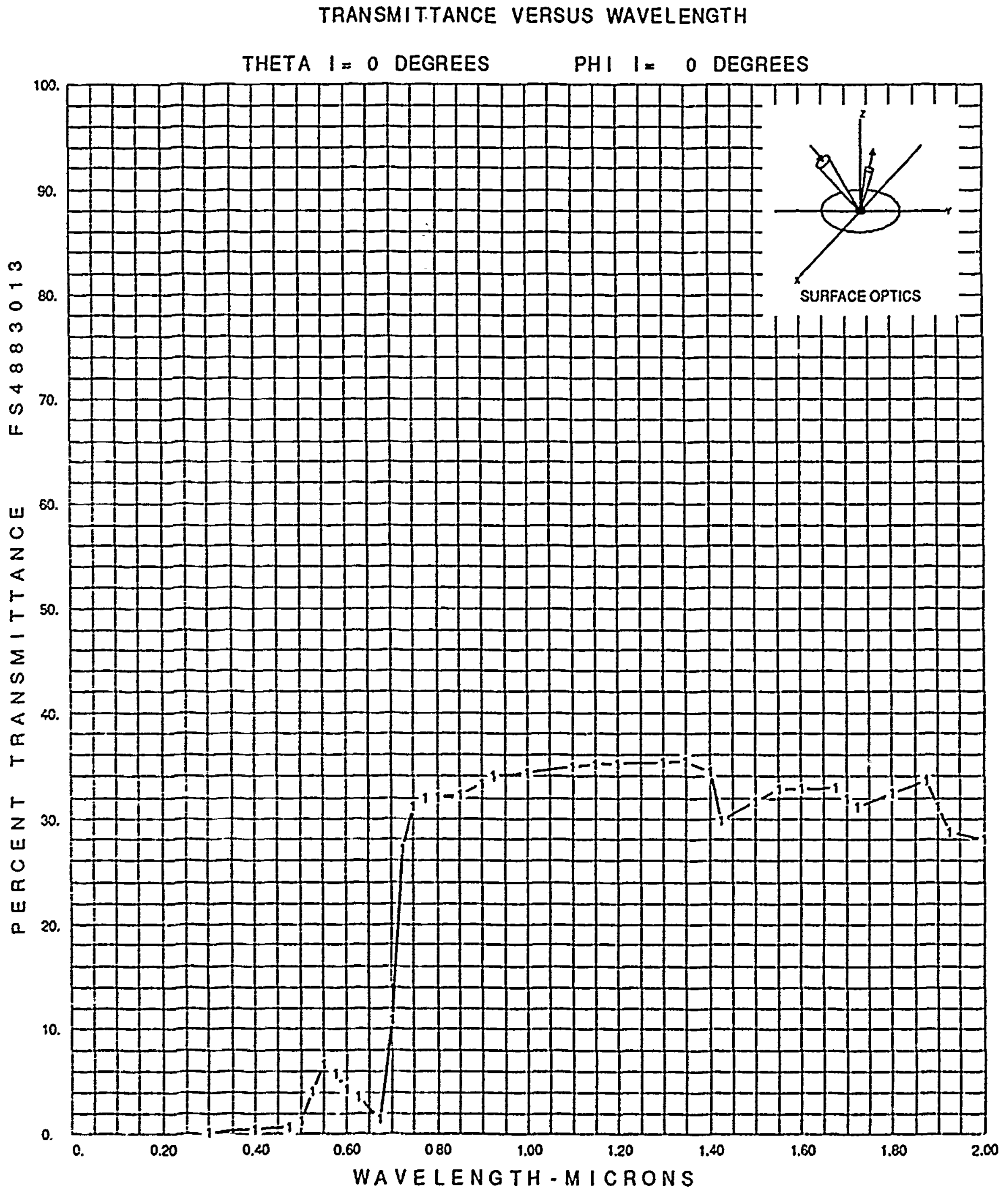

FIGURE V-2. SPECTRAL SCIENCES: GREEN ASPEN LEAF. TRANSMITTANCE SAMPLE #2 SCATTERED TRANSMITTANCE VS. WAVELENGTH BANDWIDTH 0.3 TO 2.0 MICROMETERS

APPENDIX V

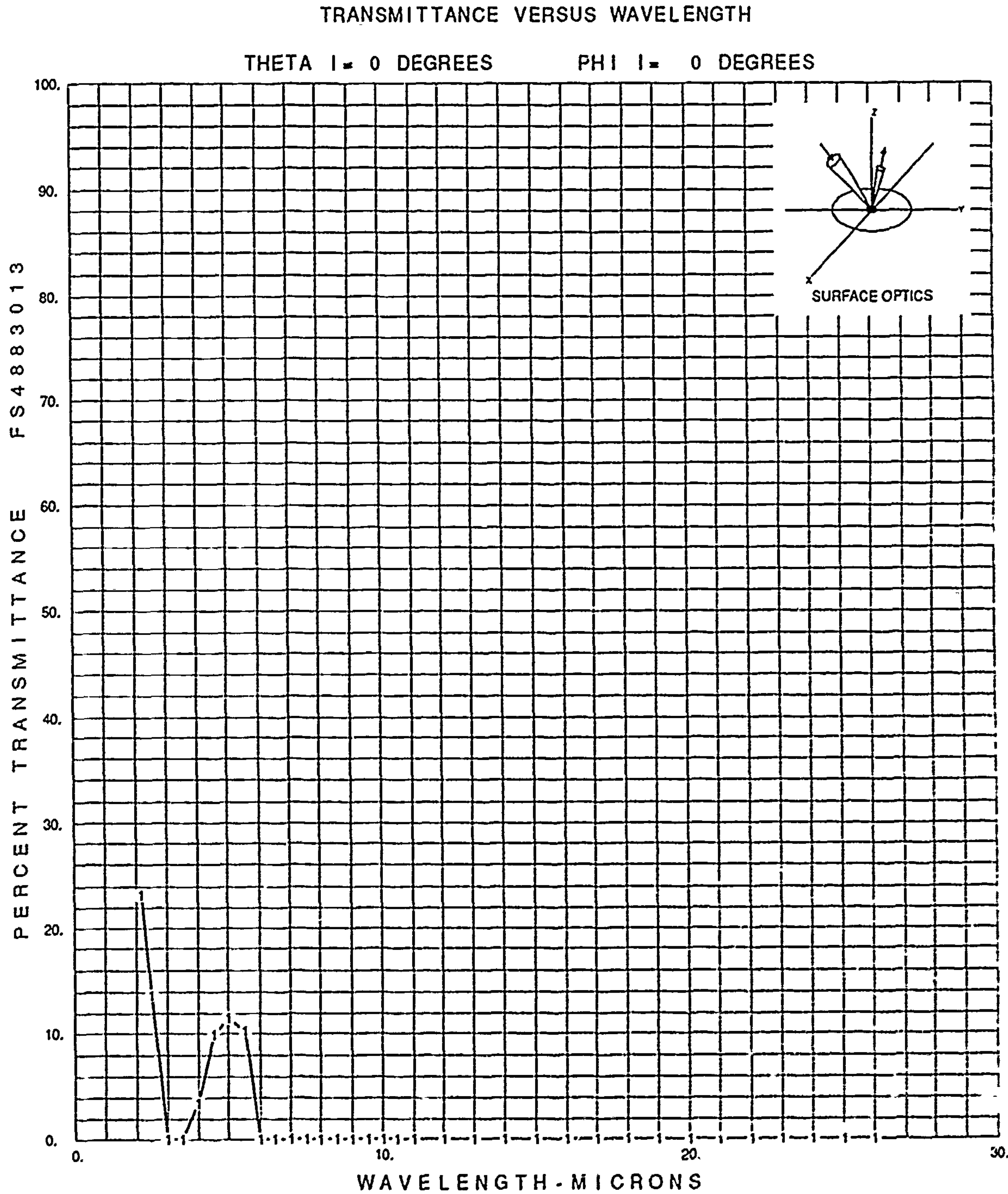

FIGURE V-3. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
TRANSMITTANCE SAMPLE #2
SCATTERED TRANSMITTANCE VS. WAVELENGTH
BANDWIDTH 2.2 TO 26.0 MICROMETERS

APPENDIX V

TABLE V-1. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
TRANSMITTANCE SAMPLE #2
SCATTERED TRANSMITTANCE VS. WAVELENGTH - ERAS DATA

FS48830135001		1	31								
FS48830135101		SPECTRAL SCIENCES: GREEN ASPEN LEAF. TRANSMITTANCE SAMPLE #2									
FS48830135102		SCATTERED TRANSMITTANCE									
FS48830137001		102390									
FS48830139001	1		001 31	.3	26.	71				0.	0.
FS48830139201	1	.3	0.2	.4	0.5	.475	0.7	.5	1.3	.525	4.1
FS48830139202	1	.55	6.6	.575	5.8	.6	4.3	.625	3.6	.675	1.5
FS48830139203	1	.7	10.9	.725	27.1	.75	31.2	.775	32.0	.8	32.1
FS48830139204	1	.85	32.3	.9	33.4	.925	34.0	1.	34.4	1.1	34.9
FS48830139205	1	1.15	35.1	1.2	35.2	1.3	35.4	1.35	35.5	1.4	34.5
FS48830139206	1	1.425	29.9	1.5	31.6	1.55	32.8	1.6	32.8	1.675	32.9
FS48830139207	1	1.7	32.0	1.725	31.2	1.8	32.4	1.875	33.6	1.9	31.2
FS48830139208	1	1.925	28.8	2.	28.0	2.2	23.2	2.5	13.6	3.	0.0
FS48830139209	1	3.5	0.0	4.	3.5	4.5	9.9	5.	11.5	5.5	10.3
FS48830139210	1	6.	0.0	6.5	0.0	7.	0.0	7.5	0.0	8.	0.0
FS48830139211	1	8.5	0.0	9.	0.0	9.5	0.0	10.	0.0	10.5	0.0
FS48830139212	1	11.	0.0	12.	0.0	13.	0.0	14.	0.0	15.	0.0
FS48830139213	1	16.	0.0	17.	0.0	18.	0.0	19.	0.0	20.	0.0
FS48830139214	1	21.	0.0	22.	0.0	23.	0.0	24.	0.0	25.	0.0
FS48830139215	1	26.	0.0								

APPENDIX W

SPECTRAL SCIENCES INC.
GREEN ASPEN LEAF,
TRANSMITTANCE #3
FS4884:

INDEX TO APPENDIX W

PAGE NO.

SCATTERED TRANSMITTANCE

APPENDIX W

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APPENDIX W

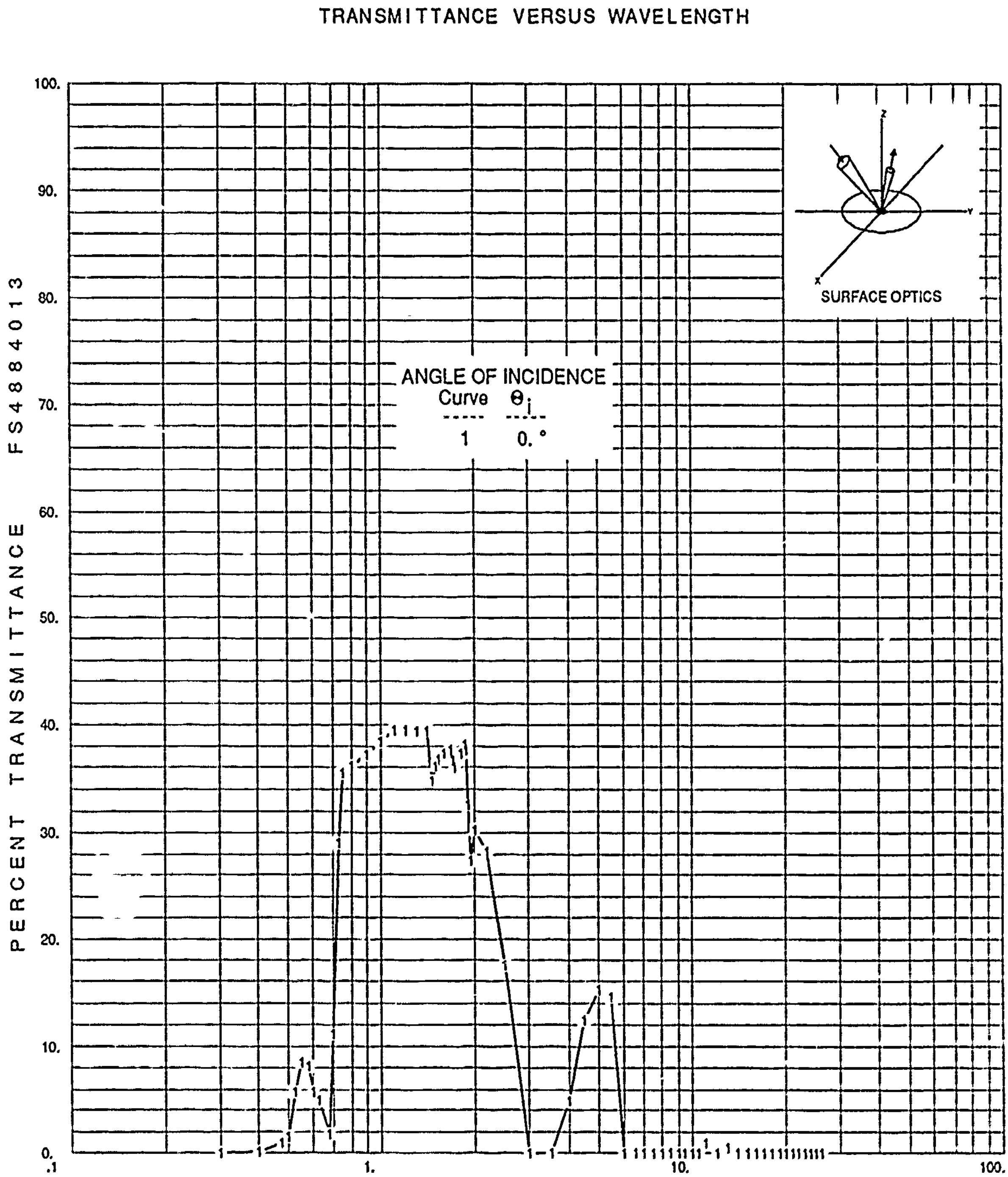

FIGURE W-1. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
TRANSMITTANCE SAMPLE #3
SCATTERED TRANSMITTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 26.0 MICROMETERS

APPENDIX W

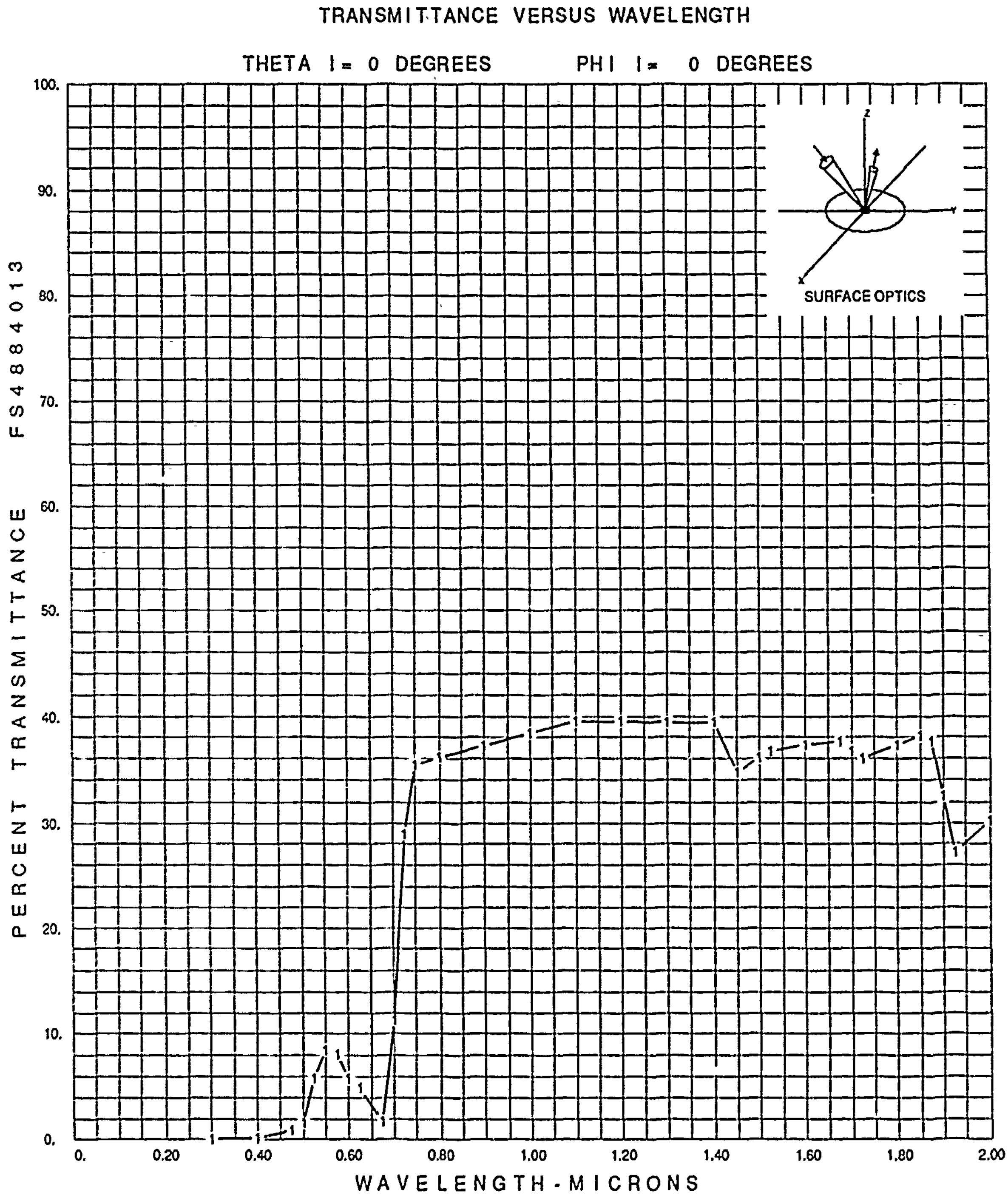

FIGURE W-2. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
TRANSMITTANCE SAMPLE #3
SCATTERED TRANSMITTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 2.0 MICROMETERS

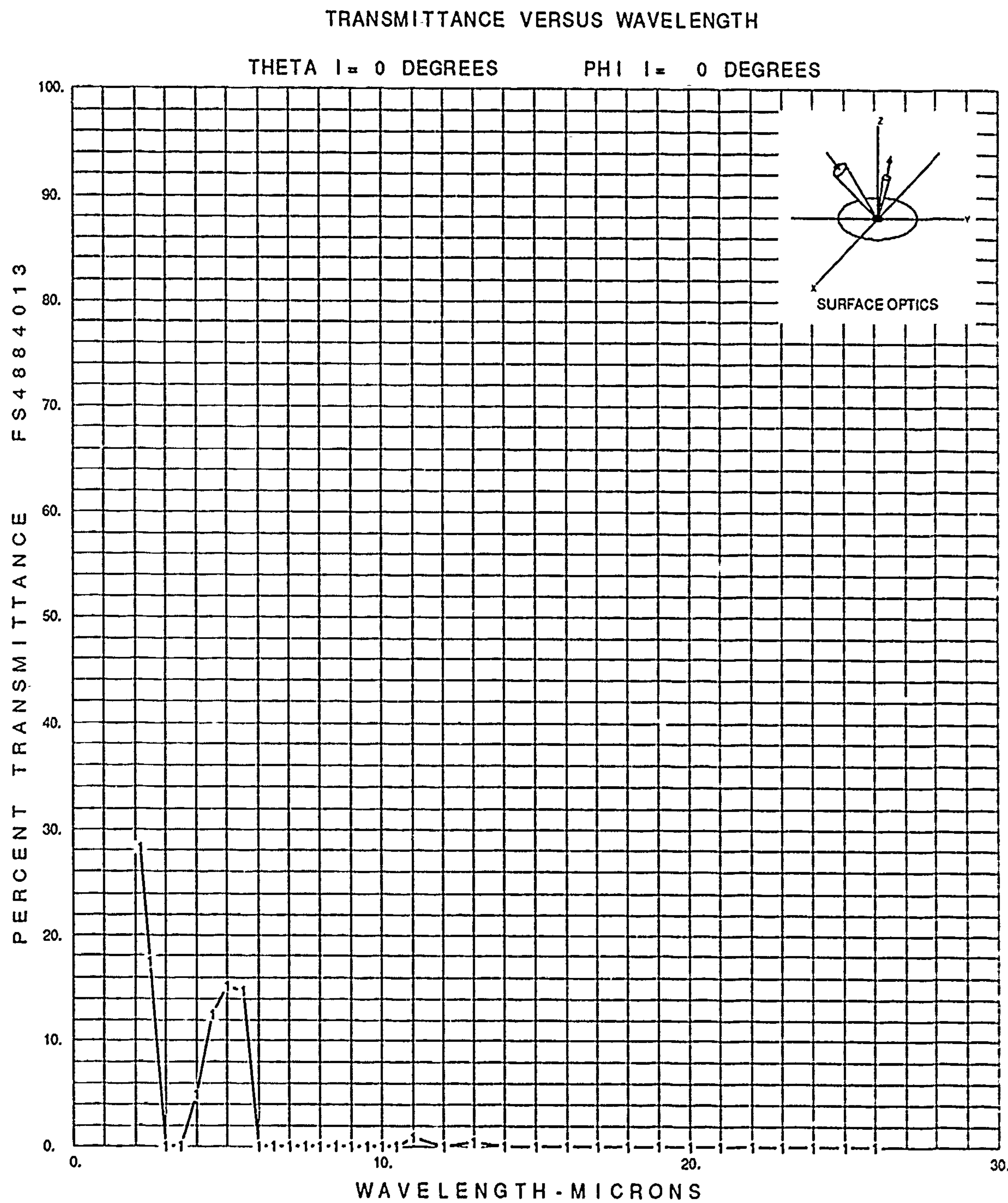

FIGURE W-3. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
TRANSMITTANCE SAMPLE #3
SCATTERED TRANSMITTANCE VS. WAVELENGTH
BANDWIDTH 2.2 TO 26.0 MICROMETERS

APPENDIX W

TABLE W-1. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
TRANSMITTANCE SAMPLE #3
SCATTERED TRANSMITTANCE VS. WAVELENGTH - ERAS DATA

```
FS48840135001          1     31
FS48840135101        SPECTRAL SCIENCES: GREEN ASPEN LEAF. TRANSMITTANCE SAMPLE #3
FS48840135102        SCATTERED TRANSMITTANCE
FS48840137001        102390
FS48840139001    1        001 31     .3    26.   67                              0.        0.
FS48840139201    1      .3    0.1    .4    0.2  .475    0.9    .5    1.6  .525    5.8
FS48840139202    1     .55    8.5  .575    8.1    .6    5.8  .625    4.9  .675    1.8
FS48840139203    1      .7   11.2  .725   29.0   .75   35.5    .8   36.1    .9   37.2
FS48840139204    1      1.   38.4   1.1   39.5   1.2   39.5   1.3   39.4   1.4   39.4
FS48840139205    1    1.45   34.7   1.5   36.1 1.525   36.8   1.6   37.3 1.675   37.7
FS48840139206    1     1.7   36.8 1.725   36.0   1.8   37.3  1.85   38.1 1.875   37.7
FS48840139207    1     1.9   32.5 1.925   27.3    2.   30.2   2.2   28.2   2.5   17.5
FS48840139208    1      3.    0.0   3.5    0.0    4.    4.9   4.5   12.4    5.   15.2
FS48840139209    1     5.5   14.6    6.    0.0   6.5    0.0    7.    0.0   7.5    0.0
FS48840139210    1      8.    0.0   8.5    0.0    9.    0.0   9.5    0.0   10.    0.0
FS48840139211    1    10.5    0.0   11.    0.9   12.    0.0   13.    0.5   14.    0.0
FS48840139212    1     15.    0.0   16.    0.0   17.    0.0   18.    0.0   19.    0.0
FS48840139213    1     20.    0.0   21.    0.0   22.    0.0   23.    0.0   24.    0.0
FS48840139214    1     25.    0.0   26.    0.0
```

APPENDIX X

SPECTRAL SCIENCES INC.
GREEN ASPEN LEAF,
TRANSMITTANCE #4
FS4885:

INDEX TO APPENDIX X

PAGE NO.

SCATTERED TRANSMITTANCE

APPENDIX X

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APPENDIX X

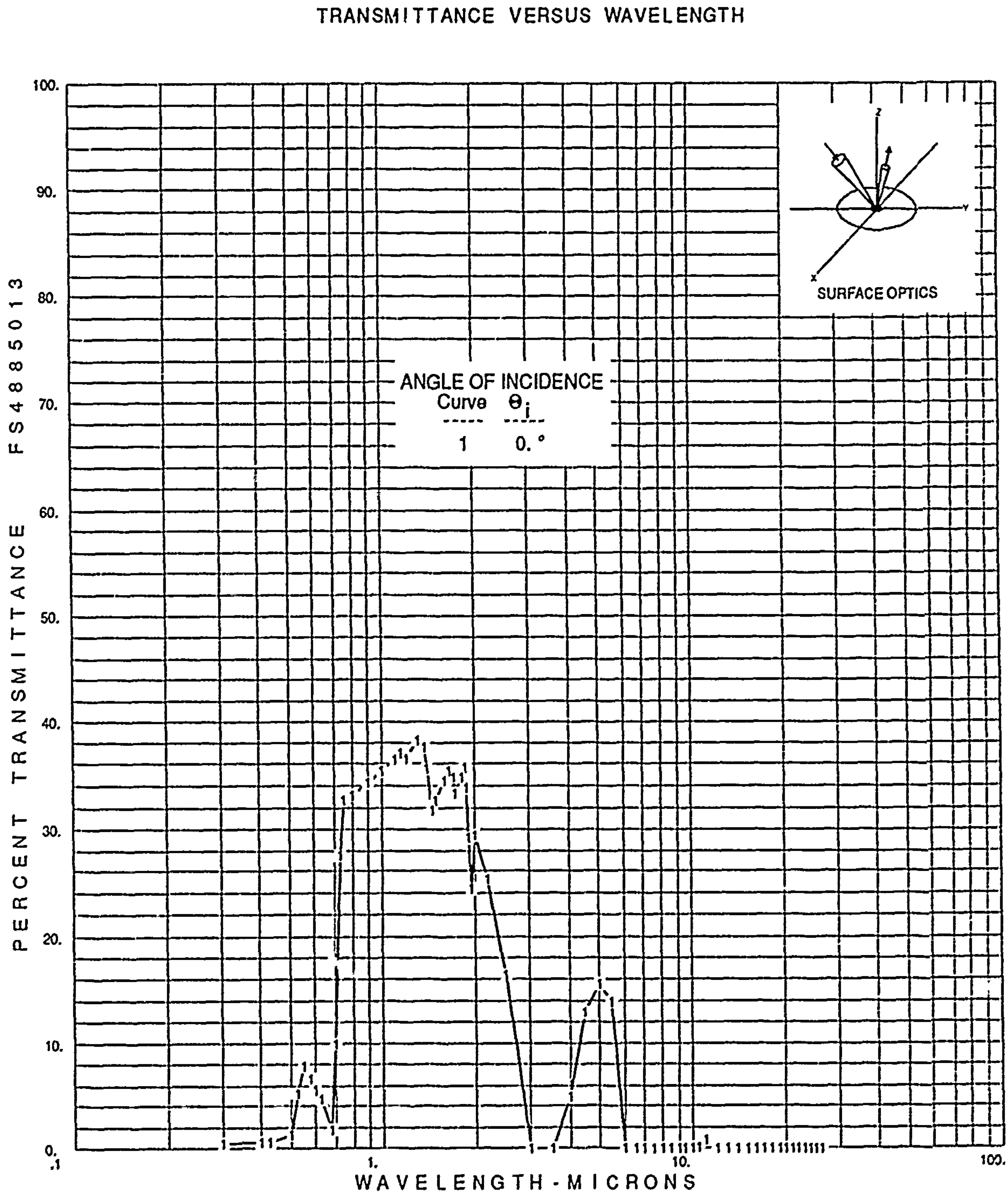

FIGURE X-1. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
TRANSMITTANCE SAMPLE #4
SCATTERED TRANSMITTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 26.0 MICROMETERS

APPENDIX X

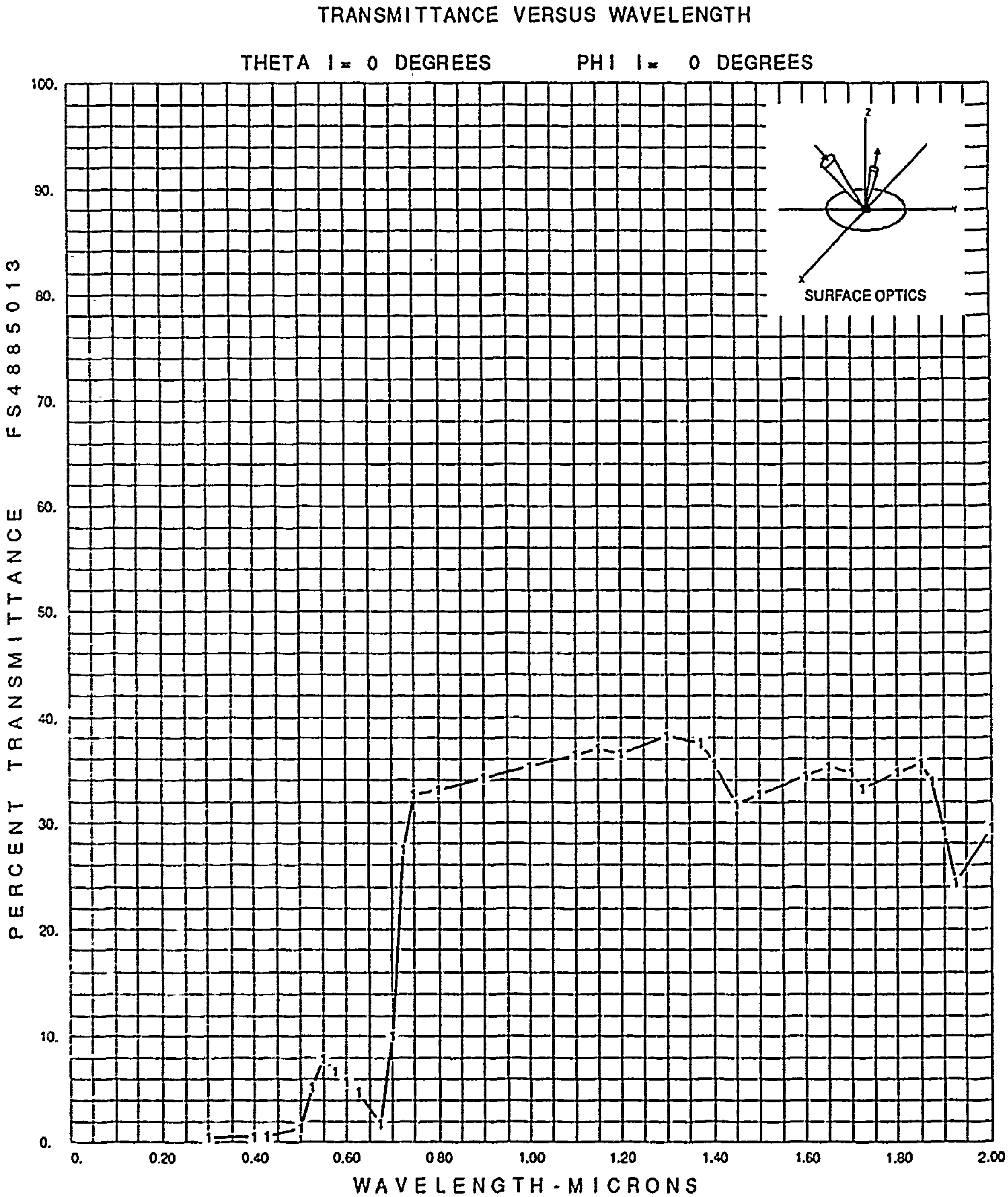

FIGURE X-2. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
TRANSMITTANCE SAMPLE #4
SCATTERED TRANSMITTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 2.0 MICROMETERS

APPENDIX X

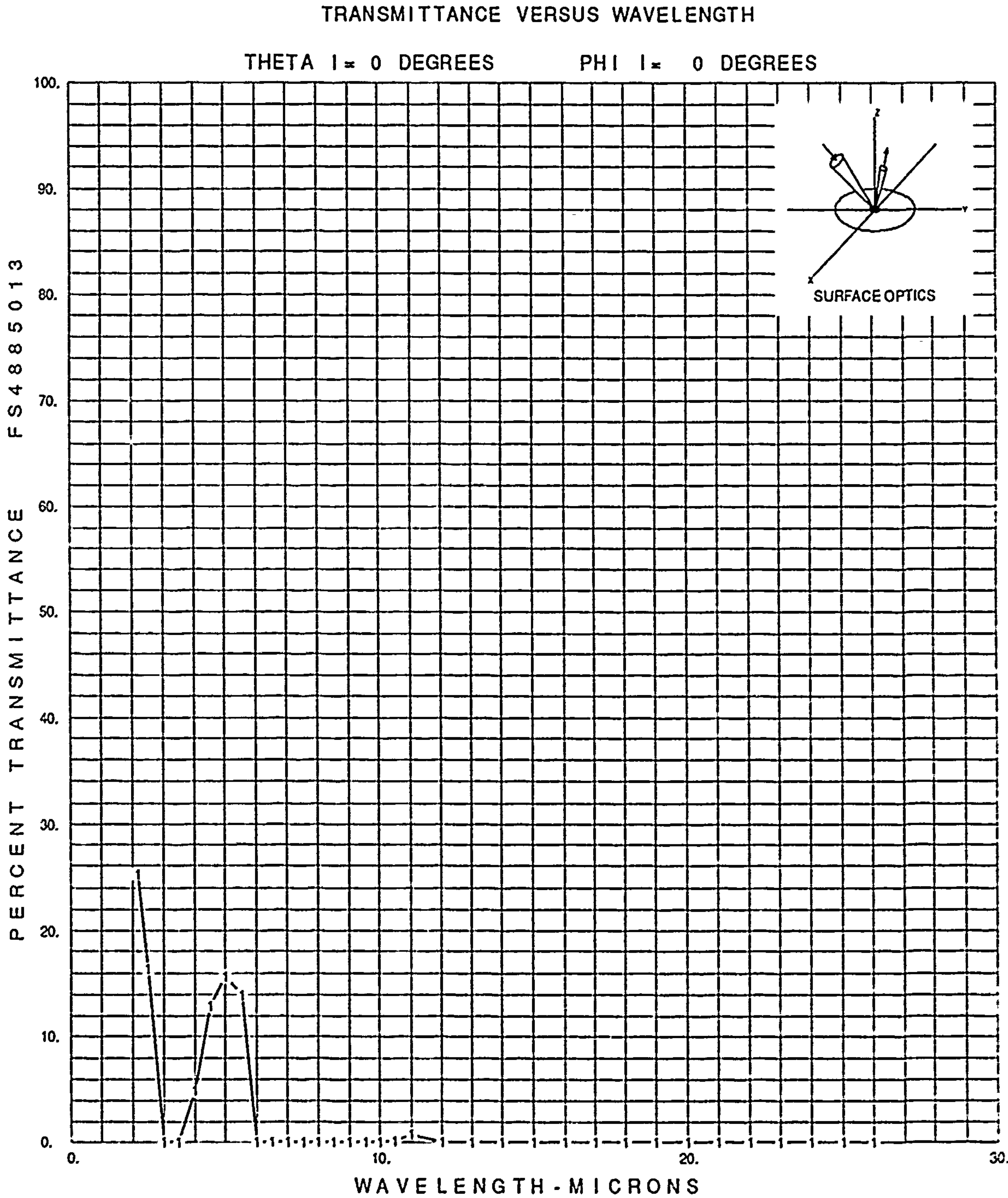

FIGURE X-3. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
TRANSMITTANCE SAMPLE #4
SCATTERED TRANSMITTANCE VS. WAVELENGTH
BANDWIDTH 2.2 TO 26.0 MICROMETERS

APPENDIX X

TABLE X-1. SPECTRAL SCIENCES: GREEN ASPEN LEAF.
TRANSMITTANCE SAMPLE #4
SCATTERED TRANSMITTANCE VS. WAVELENGTH - ERAS DATA

FS48850135001		1	31								
FS48850135101		SPECTRAL SCIENCES: GREEN ASPEN LEAF. TRANSMITTANCE SAMPLE #4									
FS48850135102		SCATTERED TRANSMITTANCE									
FS48850137001		102390									
FS48850139001	1	001 31		.3	26.	68				0.	0.
FS48850139201	1	.3	0.5	.4	0.6	.425	0.6	.5	1.4	.525	5.2
FS48850139202	1	.55	7.8	.575	6.6	.6	5.6	.625	4.7	.675	1.8
FS48850139203	1	.7	10.0	.725	27.5	.75	32.6	.8	33.1	.9	34.3
FS48850139204	1	1.	35.4	1.1	36.5	1.15	37.0	1.2	36.6	1.3	38.2
FS48850139205	1	1.375	37.6	1.4	35.6	1.45	31.7	1.5	32.6	1.6	34.5
FS48850139206	1	1.65	35.4	1.7	34.7	1.725	33.3	1.8	34.7	1.85	35.7
FS48850139207	1	1.875	33.8	1.9	29.1	1.925	24.4	2.	29.4	2.2	25.3
FS48850139208	1	2.5	16.4	3.	0.0	3.5	0.0	4.	4.9	4.5	12.9
FS48850139209	1	5.	15.6	5.5	13.9	6.	0.0	6.5	0.0	7.	0.0
FS48850139210	1	7.5	0.0	8.	0.0	8.5	0.0	9.	0.0	9.5	0.0
FS48850139211	1	10.	0.1	10.5	0.2	11.	0.8	12.	0.0	13.	0.0
FS48850139212	1	14.	0.0	15.	0.0	16.	0.0	17.	0.0	18.	0.0
FS48850139213	1	19.	0.0	20.	0.0	21.	0.0	22.	0.0	23.	0.0
FS48850139214	1	24.	0.0	25.	0.0	26.	0.0				

APPENDIX Y

ADDITIONAL BACKGROUND MATERIALS

INDEX TO APPENDIX Y

INDEX TO APPENDIX Y (continued)

PAGE NO.

DIRECTIONAL REFLECTANCE FS4052: Y-1 (continued)

DIRECTIONAL REFLECTANCE ON BROAD BLADE GRASS FS4053: Y-2

INDEX TO APPENDIX Y (continued)

INDEX TO APPENDIX Y (continued)

INDEX TO APPENDIX Y (continued)

PAGE NO.

DIRECTIONAL REFLECTANCE FS4056: Y-5 (continued)

APPENDIX Y

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APPENDIX Y

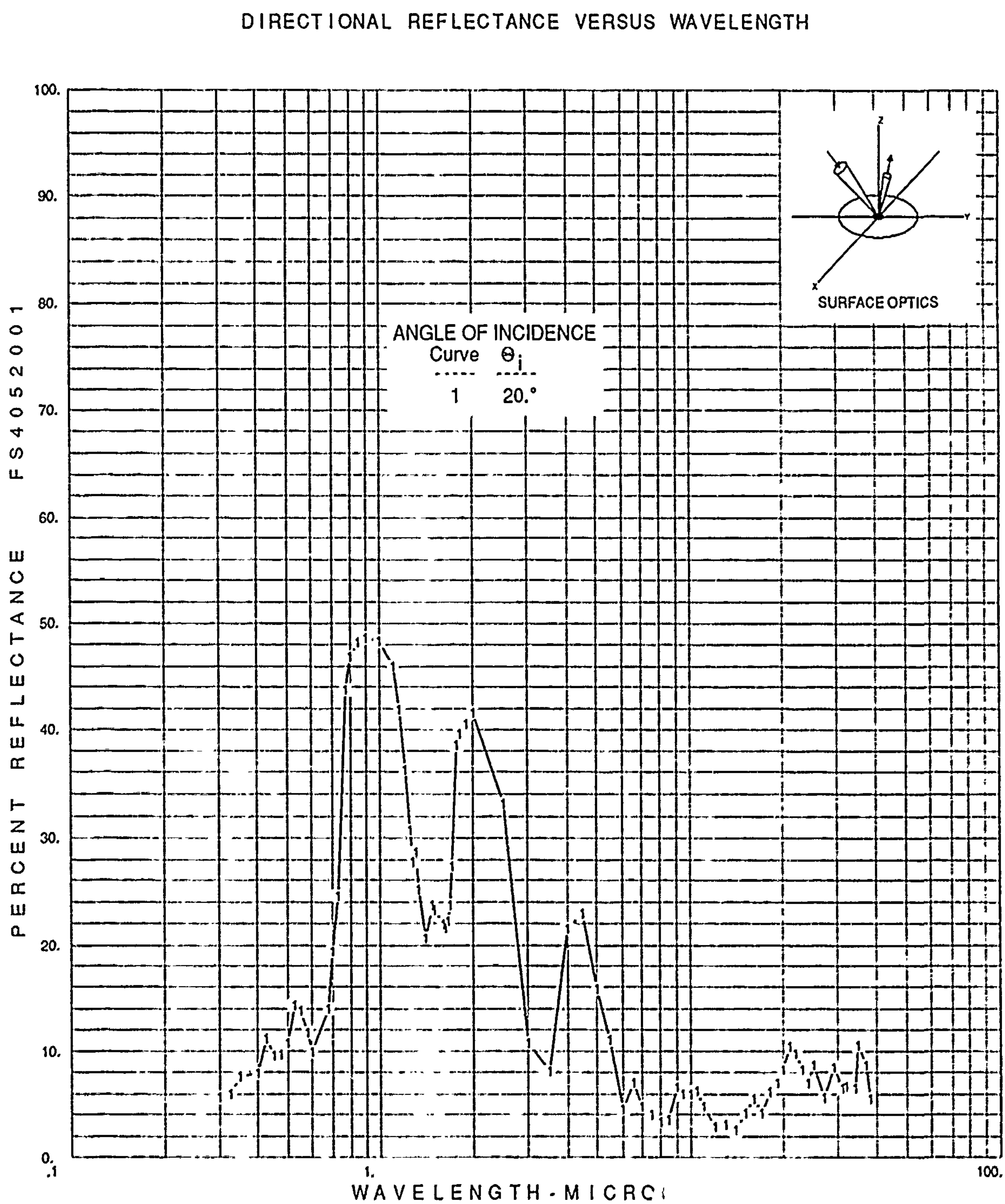

FIGURE Y-1-1. AFSC: GREEN PAINT ON ARMY TANK
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 38.0 MIC.-OMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

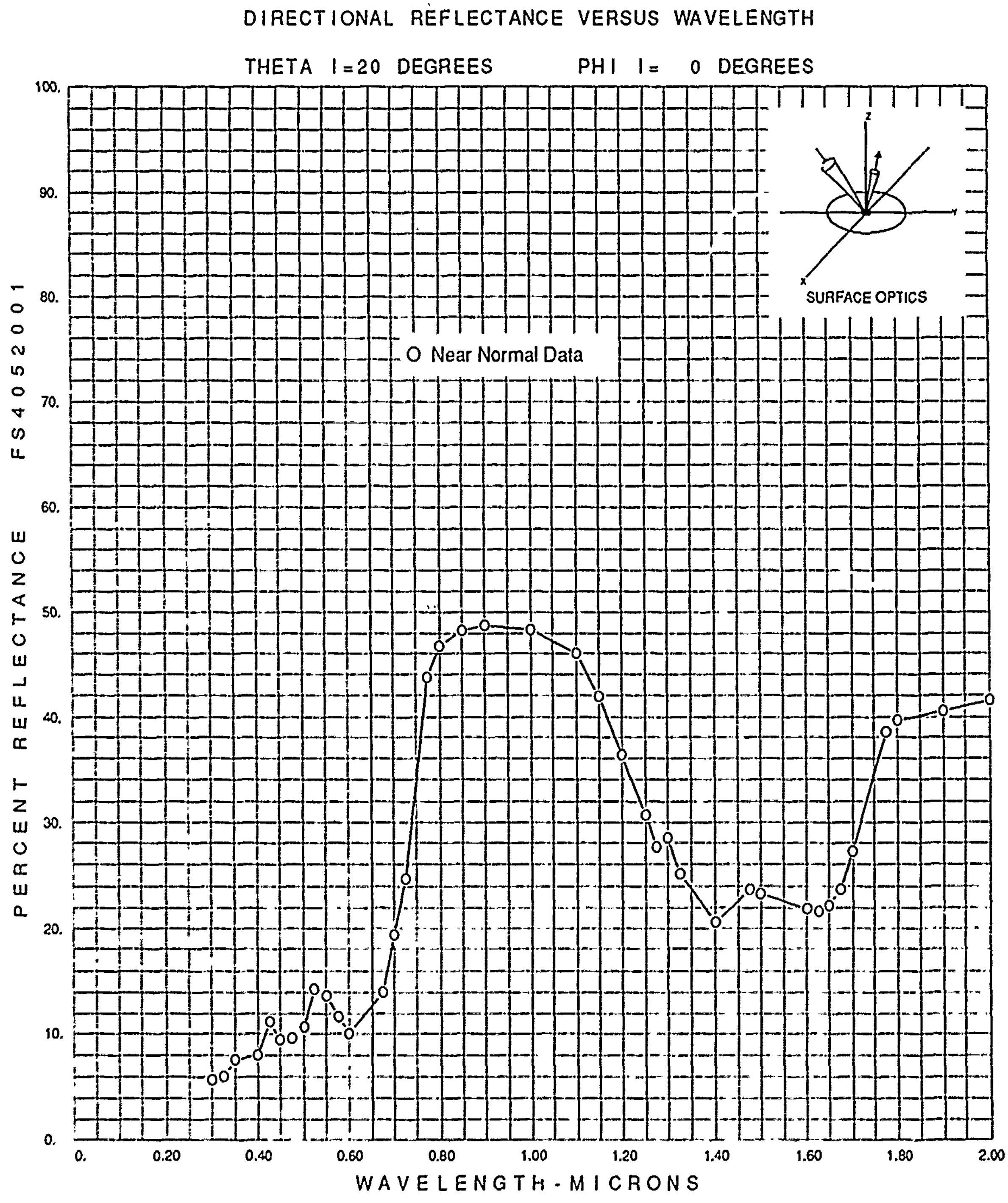

FIGURE Y-1-2. AFSC: GREEN PAINT ON ARMY TANK
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 2.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

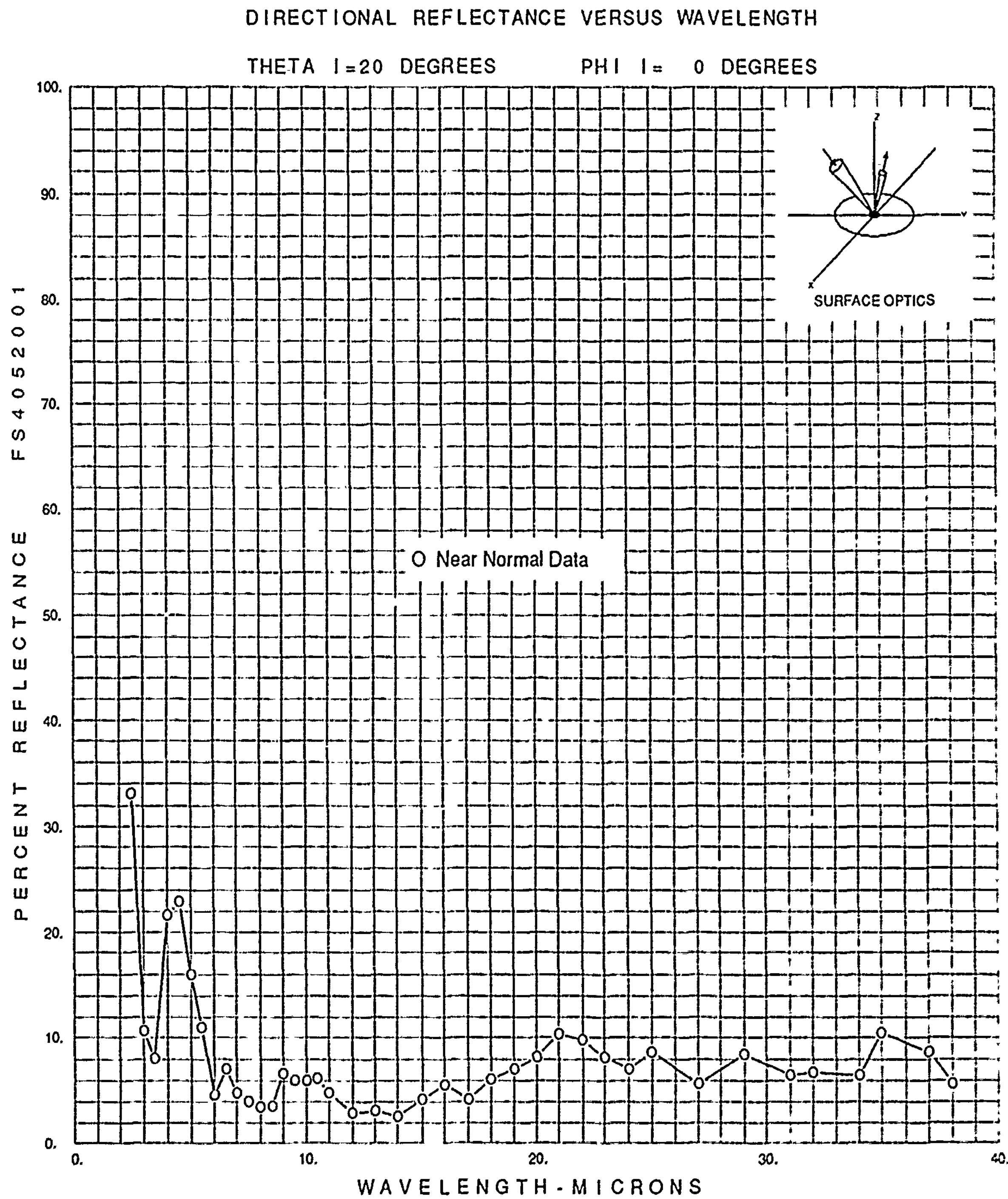

FIGURE Y-1-3. AFSC: GREEN PAINT ON ARMY TANK
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 2.5 TO 38.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX Y

TABLE Y-1-1. AFSC: GREEN PAINT ON ARMY TANK
DIRECTIONAL REFLECTANCE VS. WAVELENGTH - ERAS DATA
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

FS40520015001		1	1								
FS40520015101		AFSC: GREEN PAINT ON ARMY TANK									
FS40520015102		UNCORRECTED FOR INSTRUMENTATION POLARIZATION EFFECTS									
FS40520017001		082886									
FS40520019001	1	001	1	.3	38.	79				20.	0.
FS40520019201	1	.3	5.7	.325	6.0	.35	7.6	.4	7.9	.425	11.1
FS40520019202	1	.45	9.5	.475	9.6	.5	10.7	.525	14.3	.55	13.7
FS40520019203	1	.575	11.7	.6	10.0	.675	14.0	.7	19.3	.725	24.6
FS40520019204	1	.775	43.7	.8	46.8	.85	48.2	.9	48.7	1.	48.3
FS40520019205	1	1.1	46.0	1.15	41.9	1.2	36.3	1.25	30.7	1.275	27.7
FS40520019206	1	1.3	28.6	1.325	25.2	1.4	20.6	1.475	23.6	1.5	23.3
FS40520019207	1	1.6	21.9	1.625	21.6	1.65	22.2	1.675	23.6	1.7	27.3
FS40520019208	1	1.775	38.5	1.8	39.6	1.9	40.5	2.	41.5	2.5	33.1
FS40520019209	1	3.	10.7	3.5	8.1	4.	21.5	4.5	22.9	5.	15.9
FS40520019210	1	5.5	11.0	6.	4.6	6.5	7.1	7.	4.8	7.5	4.0
FS40520019211	1	8.	3.4	8.5	3.6	9.	6.6	9.5	6.0	10.	6.0
FS40520019212	1	10.5	6.2	11.	4.8	12.	2.9	13.	3.1	14.	2.6
FS40520019213	1	15.	4.2	16.	5.5	17.	4.2	18.	6.1	19.	7.1
FS40520019214	1	20.	8.2	21.	10.4	22.	9.8	23.	8.2	24.	7.1
FS40520019215	1	25.	8.7	27.	5.7	29.	8.5	31.	6.5	32.	6.7
FS40520019216	1	34.	6.5	35.	10.5	37.	8.7	38.	5.6		

APPENDIX Y

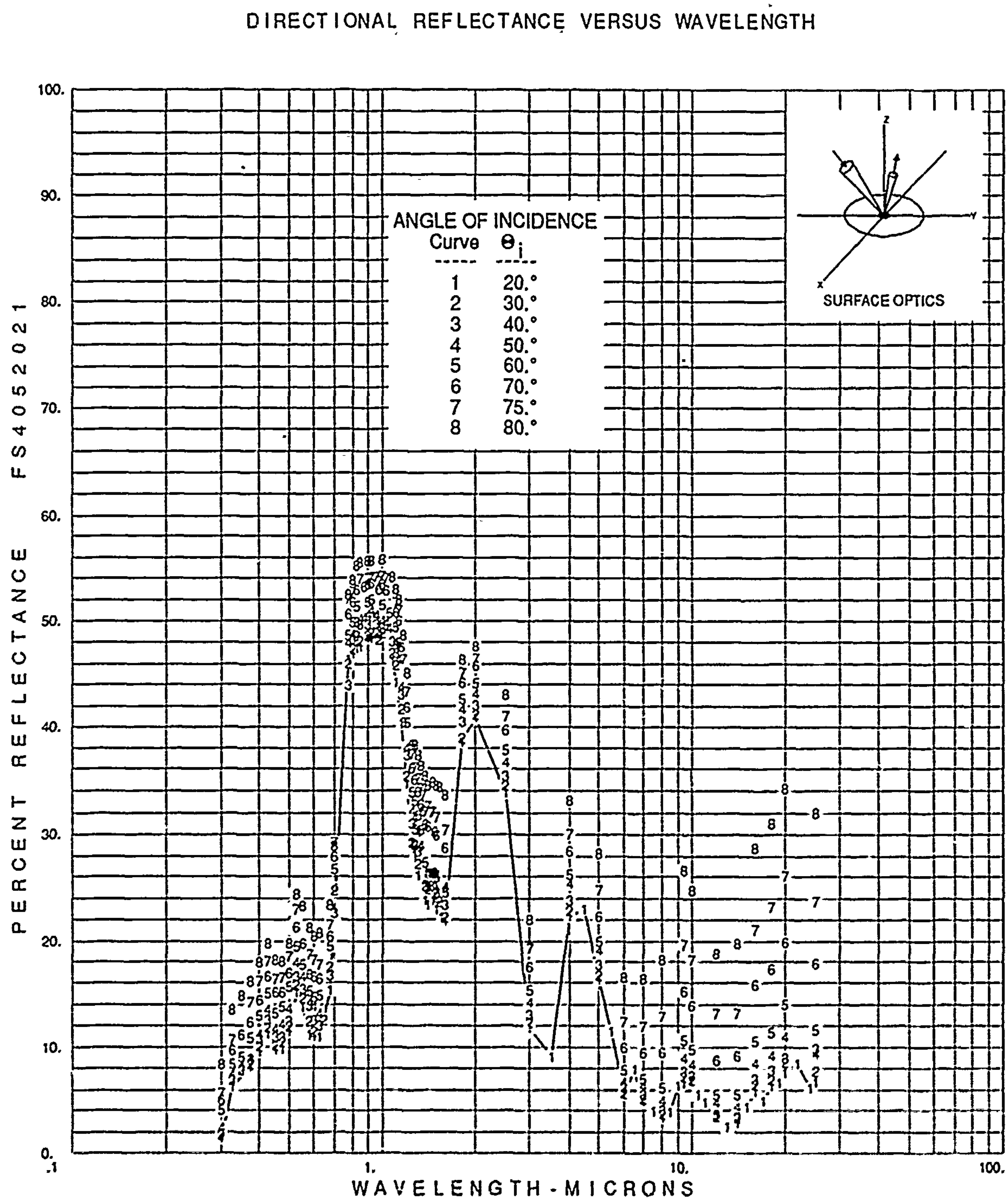

FIGURE Y-1-4. AFSC: GREEN PAINT ON ARMY TANK
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 25.0 MICROMETERS
DATA CORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX Y

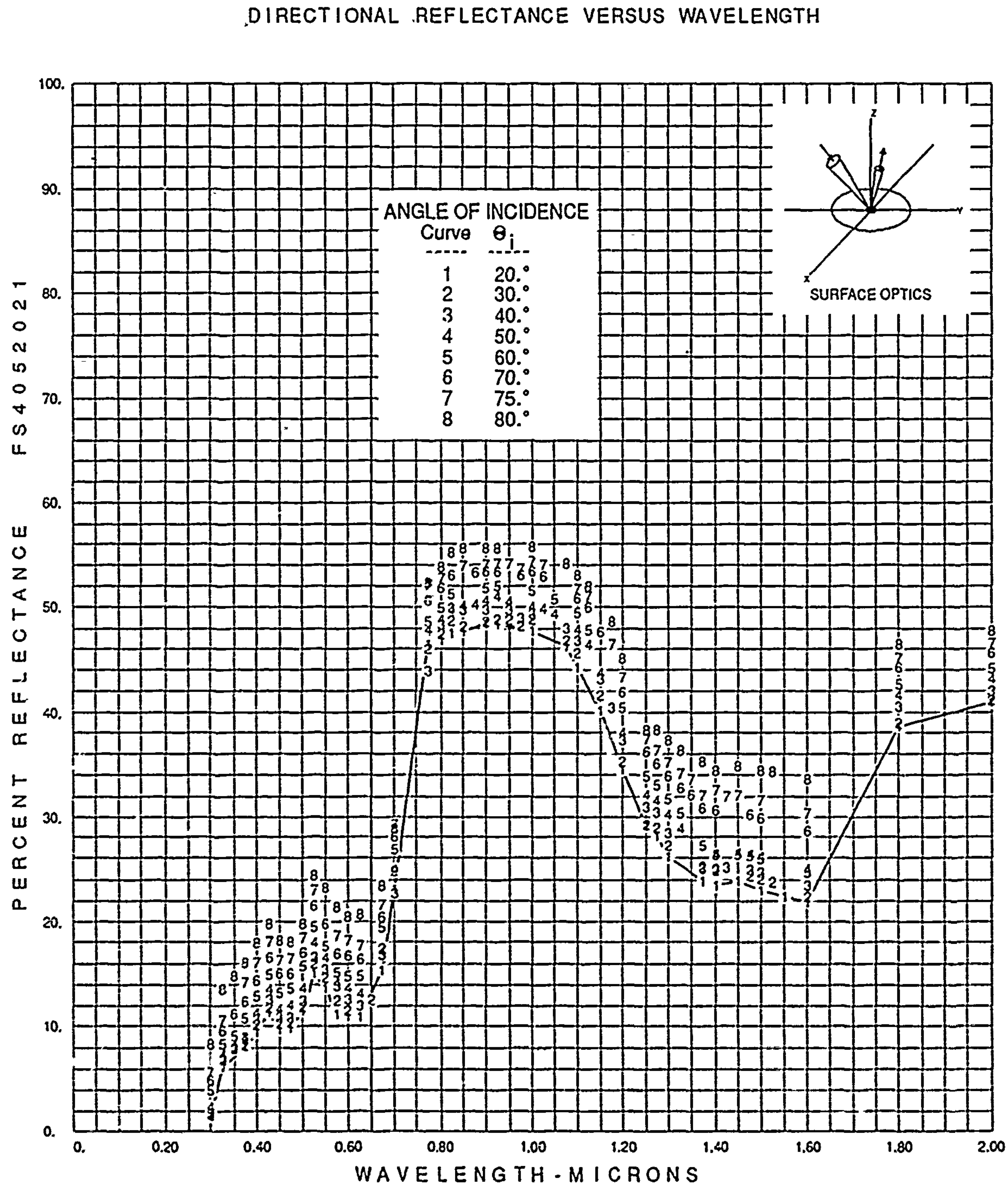

FIGURE Y-1-5. AFSC: GREEN PAINT ON ARMY TANK
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 2.0 MICROMETERS
DATA CORRECTED FOR INSTRUMENTATION POLARIZATION

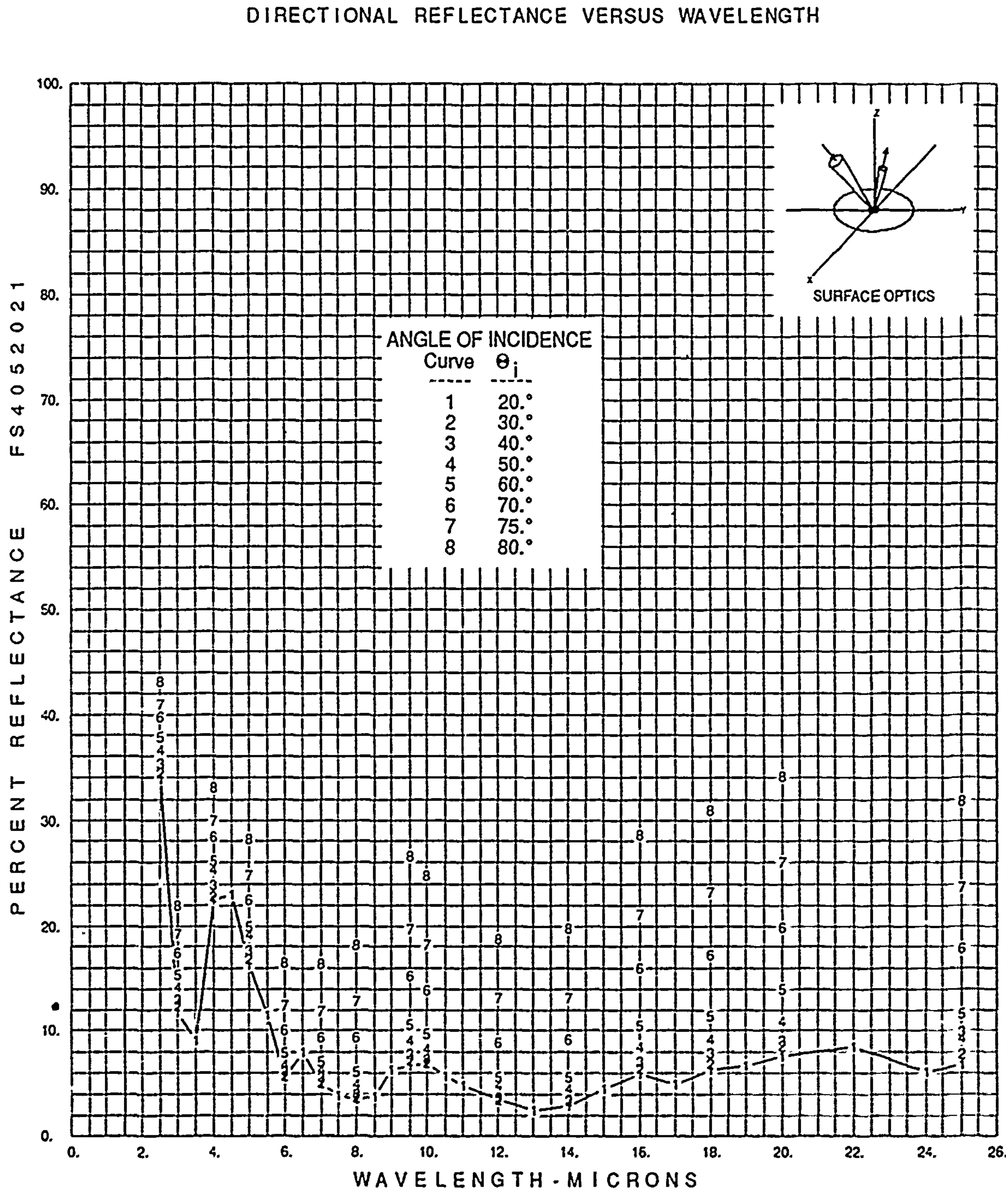

FIGURE Y-1-6. AFSC: GREEN PAINT ON ARMY TANK
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 2.5 TO 25.0 MICROMETERS
DATA CORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX Y

TABLE Y-1-2. AFSC: GREEN PAINT ON ARMY TANK
DIRECTIONAL REFLECTANCE VS. WAVELENGTH - ERAS DATA
DATA CORRECTED FOR INSTRUMENTATION POLARIZATION

```
FS40520215001          8      1
FS40520215101       AFSC: GREEN PAINT ON ARMY TANK
FS40520215102       CORRECTED FOR INSTRUMENTATION POLARIZATION EFFECTS
FS40520217001       081886
FS40520219001   1         001  1     .3    25.  67                           20.      0.
FS40520219201   1      .3   1.5  .325   6.2  .375   8.1    .4   9.5  .425  11.3
FS40520219202   1     .45   9.7  .475   9.9    .5  11.5  .525  15.1   .55  13.7
FS40520219203   1    .575  11.1    .6  11.0  .625  10.9  .675  15.4    .7  23.1
FS40520219204   1    .775  46.4    .8  46.9  .825  47.5   .85  47.7    .9  48.4
FS40520219205   1    .925  48.4    1.  47.7 1.075  46.2   1.1  44.2  1.15  40.2
FS40520219206   1     1.2  34.6  1.25  29.1 1.275  28.1   1.3  26.1 1.375  23.8
FS40520219207   1     1.4  23.4  1.45  23.8   1.5  23.0  1.55  22.3   1.6  21.9
FS40520219208   1     1.8  38.6    2.  40.9   2.5  33.8    3.  11.8   3.5   9.1
FS40520219209   1      4.  22.4   4.5  23.0    5.  16.3   5.5  11.5    6.   5.5
FS40520219210   1     6.5   7.9    7.   4.9   7.5   3.9    8.   3.4   8.5   3.8
FS40520219211   1      9.   6.3   9.5   6.6   10.   6.8  10.5   5.6   11.   4.8
FS40520219212   1     12.   3.5   13.   2.5   14.   2.9   15.   4.4   16.   5.9
FS40520219213   1     17.   4.9   18.   6.3   19.   6.6   20.   7.6   22.   8.5
FS40520219214   1     24.   6.1   25.   6.7
FS40520219001   2         001  1     .3    25.  55                           30.      0.
FS40520219201   2      .3   1.7  .325   6.8   .35   7.8  .375   8.3    .4  10.1
FS40520219202   2    .425  11.8   .45  10.2  .475  10.4    .5  11.9  .525  15.9
FS40520219203   2     .55  14.6  .575  12.4    .6  11.5   .65  12.6  .675  17.5
FS40520219204   2      .7  24.7  .775  46.0    .8  47.4  .825  48.7   .85  48.1
FS40520219205   2      .9  48.6  .925  48.9   .95  48.9  .975  48.2    1.  48.9
FS40520219206   2   1.075  46.9   1.1  45.7  1.15  41.6   1.2  35.4  1.25  29.2
FS40520219207   2   1.275  29.0   1.3  27.2 1.375  25.3   1.4  24.8 1.475  24.4
FS40520219208   2     1.5  24.1 1.525  23.7   1.6  22.3   1.8  39.0    2.  41.2
FS40520219209   2     2.5  34.5    3.  12.3    4.  22.8    5.  16.8    6.   5.7
FS40520219210   2      7.   5.1    8.   3.7   9.5   7.2   10.   7.0   12.   3.5
FS40520219211   2     14.   3.3   16.   6.4   18.   6.9   20.   8.6   25.   7.7
FS40520219001   3         001  1     .3    25.  55                           40.      0.
FS40520219201   3      .3   1.8  .325   7.0   .35   7.9  .375   8.9    .4  10.7
FS40520219202   3    .425  12.5   .45  10.9  .475  10.9    .5  12.4  .525  16.6
FS40520219203   3     .55  15.5  .575  13.9    .6  12.5  .625  12.0  .675  16.8
FS40520219204   3      .7  22.6  .775  43.9    .8  48.3  .825  49.9   .85  49.7
FS40520219205   3      .9  49.7   .95  49.7  .975  49.0    1.  49.3 1.075  48.0
FS40520219206   3     1.1  46.9  1.15  43.1 1.175  40.4   1.2  37.3  1.25  31.0
FS40520219207   3   1.275  30.4   1.3  28.4 1.375  25.0   1.4  25.1 1.425  25.2
FS40520219208   3   1.475  24.9   1.5  24.6   1.6  23.4   1.8  40.5    2.  42.1
FS40520219209   3     2.5  35.4    3.  13.0    4.  23.8    5.  17.7    6.   6.1
FS40520219210   3      7.   5.5    8.   4.0   9.5   7.7   10.   7.3   12.   3.7
FS40520219211   3     14.   3.5   16.   7.1   18.   7.8   20.   9.0   25.   9.9
FS40520219001   4         001  1     .3    25.  57                           50.      0.
FS40520219201   4      .3   2.4  .325   7.4   .35   8.4  .375   8.9    .4  11.2
FS40520219202   4    .425  13.5   .45  11.7  .475  12.1    .5  13.6  .525  17.9
FS40520219203   4     .55  16.6  .575  14.2    .6  13.7  .625  13.1  .675  17.2
FS40520219204   4      .7  24.9  .775  47.9    .8  48.8  .825  49.7   .85  50.2
```

TABLE Y-1-2. (CONTINUED)

FS40520219205	4	.875	50.3	.9	50.6	.925	51.0	.95	50.5	1.	50.0
FS40520219206	4	1.025	49.8	1.05	49.3	1.1	47.9	1.125	46.4	1.15	43.7
FS40520219207	4	1.2	38.0	1.25	32.2	1.275	31.5	1.3	30.2	1.325	28.9
FS40520219208	4	1.4	26.4	1.45	26.5	1.475	26.4	1.5	26.1	1.6	25.0
FS40520219209	4	1.8	41.6	2.	43.2	2.5	36.7	3.	14.2	4.	25.4
FS40520219210	4	5.	19.1	6.	6.7	7.	6.3	8.	4.9	9.5	9.0
FS40520219211	4	10.	8.3	12.	4.8	14.	4.4	16.	8.5	18.	9.2
FS40520219212	4	20.	10.9	25.	9.3						
FS40520219001	5	001	1	.3	25.	53				60.	0.
FS40520219201	5	.3	4.0	.325	8.4	.35	9.1	.375	10.8	.4	12.9
FS40520219202	5	.425	15.0	.45	13.2	.475	13.7	.5	15.7	.525	19.5
FS40520219203	5	.55	17.7	.575	15.2	.6	14.7	.625	14.8	.675	19.5
FS40520219204	5	.7	26.8	.775	48.6	.8	49.9	.825	51.3	.9	51.8
FS40520219205	5	.925	52.0	1.	51.5	1.05	50.7	1.1	49.4	1.125	47.9
FS40520219206	5	1.2	40.4	1.25	33.9	1.275	33.1	1.3	31.7	1.325	30.3
FS40520219207	5	1.375	27.3	1.4	26.4	1.45	26.4	1.475	26.3	1.5	25.9
FS40520219208	5	1.6	24.6	1.8	42.6	2.	44.1	2.5	37.9	3.	15.4
FS40520219209	5	4.	26.2	5.	20.0	6.	7.8	7.	7.1	8.	6.1
FS40520219210	5	9.5	10.6	10.	9.7	12.	5.5	14.	5.5	16.	10.5
FS40520219211	5	18.	11.4	20.	14.0	25.	11.6				
FS40520219001	6	001	1	.3	25.	56				70.	0.
FS40520219201	6	.3	5.0	.325	9.6	.35	11.1	.375	12.3	.4	14.4
FS40520219202	6	.425	16.6	.45	15.1	.475	15.1	.5	17.0	.525	21.4
FS40520219203	6	.55	19.8	.575	16.9	.6	16.7	.625	16.4	.675	20.4
FS40520219204	6	.7	28.0	.775	50.6	.8	51.8	.825	53.0	.875	53.3
FS40520219205	6	.9	53.4	.925	53.5	.975	53.0	1.	53.4	1.025	52.9
FS40520219206	6	1.1	50.8	1.125	50.1	1.15	47.6	1.2	41.9	1.25	36.2
FS40520219207	6	1.275	35.1	1.3	33.9	1.325	32.7	1.35	32.2	1.375	30.9
FS40520219208	6	1.4	30.7	1.475	30.2	1.5	29.9	1.6	28.7	1.8	44.2
FS40520219209	6	2.	45.7	2.5	39.7	3.	17.5	4.	28.4	5.	22.4
FS40520219210	6	6.	10.0	7.	9.4	8.	9.4	9.5	15.3	10.	13.9
FS40520219211	6	12.	8.8	14.	9.2	16.	15.9	18.	17.3	20.	19.9
FS40520219212	6	25.	17.8								
FS40520219001	7	001	1	.3	25.	55				75.	0.
FS40520219201	7	.3	5.7	.325	10.6	.375	14.2	.4	16.1	.425	18.0
FS40520219202	7	.45	16.3	.475	16.5	.5	18.5	.525	23.0	.575	18.7
FS40520219203	7	.6	18.2	.625	17.7	.675	21.5	.7	29.2	.775	52.1
FS40520219204	7	.8	52.7	.85	53.9	.9	54.0	.925	54.1	.95	54.1
FS40520219205	7	.975	53.7	1.	54.3	1.025	54.0	1.1	51.7	1.125	51.0
FS40520219206	7	1.175	46.4	1.2	43.4	1.25	37.4	1.275	36.3	1.3	35.2
FS40520219207	7	1.325	34.2	1.35	33.6	1.375	32.1	1.4	32.5	1.425	32.0
FS40520219208	7	1.45	32.1	1.5	31.5	1.6	30.3	1.8	45.1	2.	46.5
FS40520219209	7	2.5	41.0	3.	19.2	4.	30.0	5.	24.7	6.	12.3
FS40520219210	7	7.	11.9	8.	12.8	9.5	19.7	10.	18.2	12.	13.1
FS40520219211	7	14.	13.1	16.	21.1	18.	23.2	20.	26.0	25.	23.6
FS40520219001	8	001	1	.3	25.	55				80.	0.
FS40520219201	8	.3	8.4	.325	13.5	.35	14.8	.375	16.1	.4	17.9
FS40520219202	8	.425	19.8	.45	18.2	.475	18.0	.5	19.8	.525	24.4

TABLE Y-1-2. (CONTINUED)

FS40520219203	8	.55	23.3	.575	21.3	.6	20.4	.625	20.7	.675	23.4
FS40520219204	8	.7	28.9	.775	52.4	.8	53.8	.825	55.2	.85	55.6
FS40520219205	8	.9	55.7	.925	55.7	1.	55.8	1.075	54.1	1.1	53.0
FS40520219206	8	1.125	52.0	1.175	48.6	1.2	45.1	1.25	38.3	1.275	38.3
FS40520219207	8	1.3	37.3	1.325	36.4	1.375	35.4	1.4	34.5	1.45	34.8
FS40520219208	8	1.5	34.5	1.525	34.4	1.6	33.6	1.8	46.4	2.	47.7
FS40520219209	8	2.5	43.1	3.	22.0	4.	33.1	5.	28.2	6.	16.5
FS40520219210	8	7.	16.4	8.	18.2	9.5	26.7	10.	24.7	12.	18.8
FS40520219211	8	14.	19.8	16.	28.7	18.	31.0	20.	34.2	25.	31.9

APPENDIX Y

TABLE Y-1-3. AFSC: GREEN PAINT ON ARMY TANK
DIRECTIONAL AND HEMISPHERICAL EMITTANCE
AS A FUNCTION OF INCIDENT ANGLE AND TEMPERATURE
DATA CORRECTED FOR INSTRUMENTATION POLARIZATION

FS4052021: AFSC: GREEN PAINT ON ARMY TANK
CORRECTED FOR INSTRUMENTATION POLARIZATION EFFECTS

Emittance tabulated as a function of zenith angle and temperature:

Zenith angle (degrees)	Wavelength range (microns)	Temperature (degrees Kelvin) 100	200	300	400	500	600
20	0.300 - 25.000	0.934	0.945	0.944	0.934	0.918	0.901
30	0.300 - 25.000	0.926	0.938	0.940	0.931	0.915	0.897
40	0.300 - 25.000	0.915	0.932	0.935	0.926	0.910	0.891
50	0.300 - 25.000	0.906	0.920	0.924	0.915	0.899	0.880
60	0.300 - 25.000	0.882	0.902	0.909	0.902	0.887	0.869
70	0.300 - 25.000	0.824	0.853	0.866	0.865	0.854	0.838
75	0.300 - 25.000	0.767	0.802	0.822	0.826	0.820	0.808
80	0.300 - 25.000	0.687	0.730	0.757	0.768	0.767	0.760
Hemispherical emittance:		0.877	0.895	0.900	0.894	0.880	0.863

APPENDIX Y

TABLE Y-1-4. AFSC: GREEN PAINT ON ARMY TANK
SOLAR ABSORBPTANCE AS A FUNCTION OF INCIDENT ANGLE
DATA CORRECTED FOR INSTRUMENTATION POLARIZATION

FS4052021 Surface Optics Corp.
AFSC: GREEN PAINT ON ARMY TANK

20 degrees: The exoatmospheric solar absorptance is 0.751.
30 degrees: The exoatmospheric solar absorptance is 0.743.
40 degrees: The exoatmospheric solar absorptance is 0.738.
50 degrees: The exoatmospheric solar absorptance is 0.727.
60 degrees: The exoatmospheric solar absorptance is 0.714.
70 degrees: The exoatmospheric solar absorptance is 0.695.
75 degrees: The exoatmospheric solar absorptance is 0.683.
80 degrees: The exoatmospheric solar absorptance is 0.665.

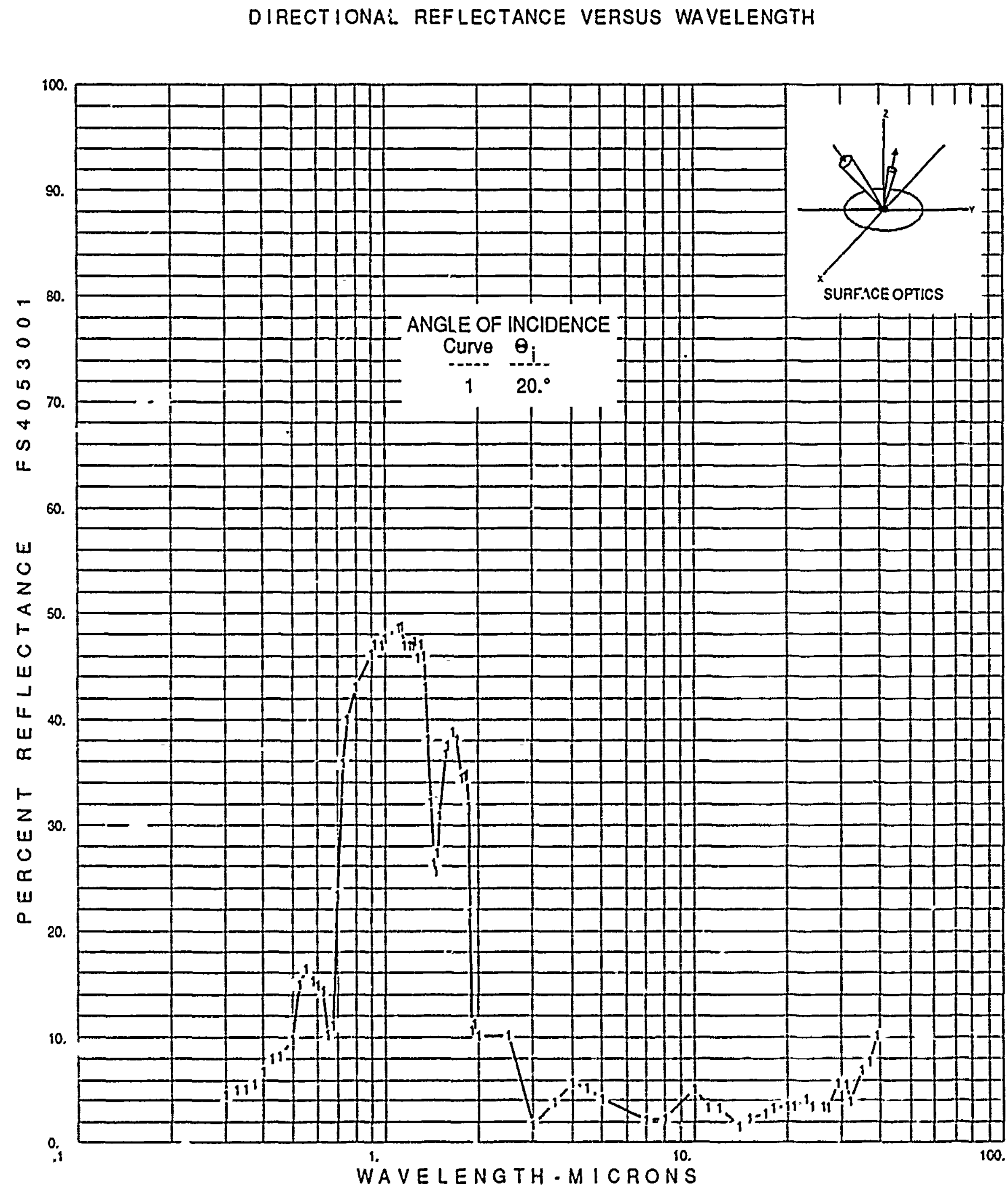

FIGURE Y-2-1. AFSC: BROAD BLADE GRASS
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 39.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX Y

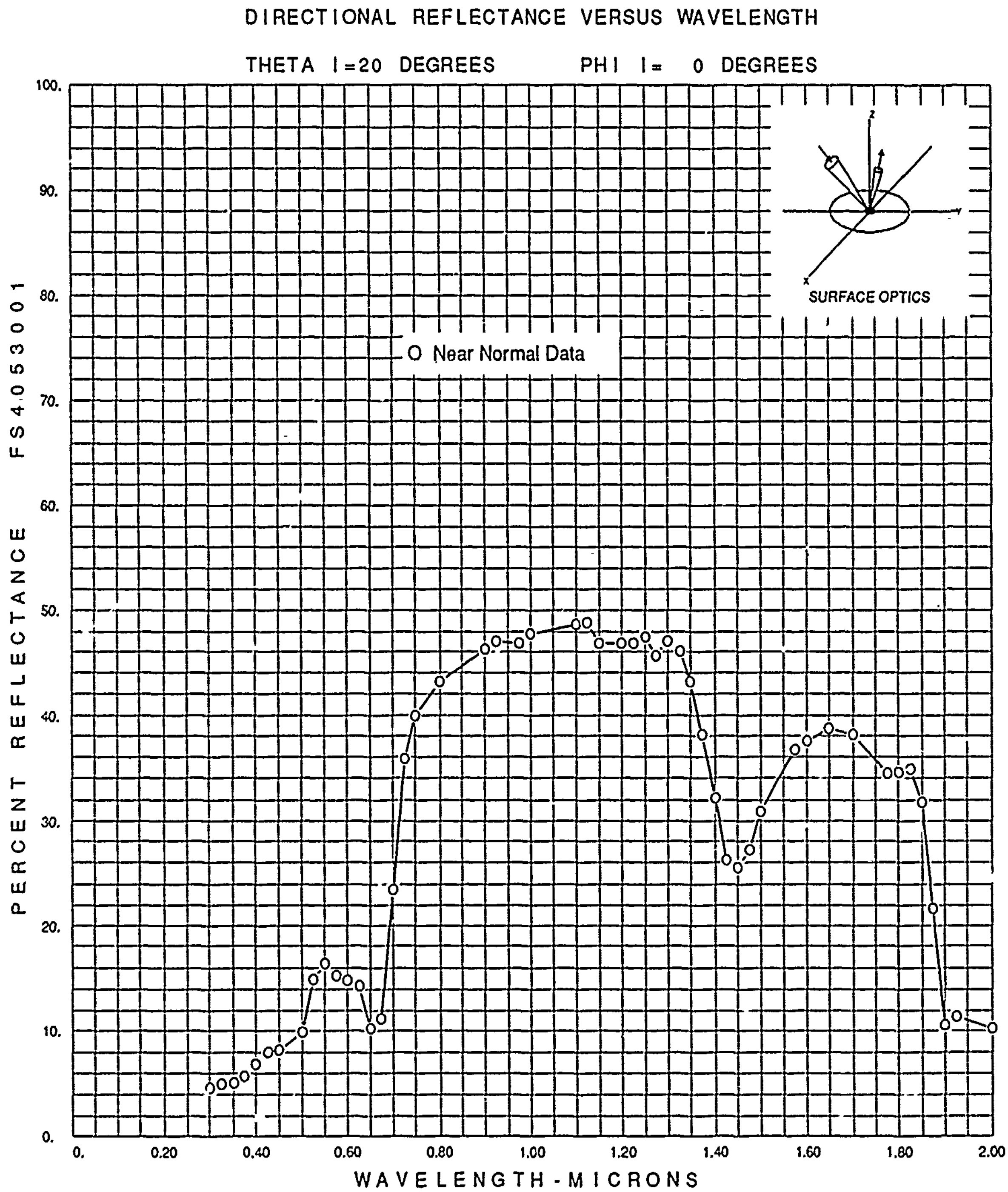

FIGURE Y-2-2. AFSC: BROAD BLADE GRASS
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 2.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX Y

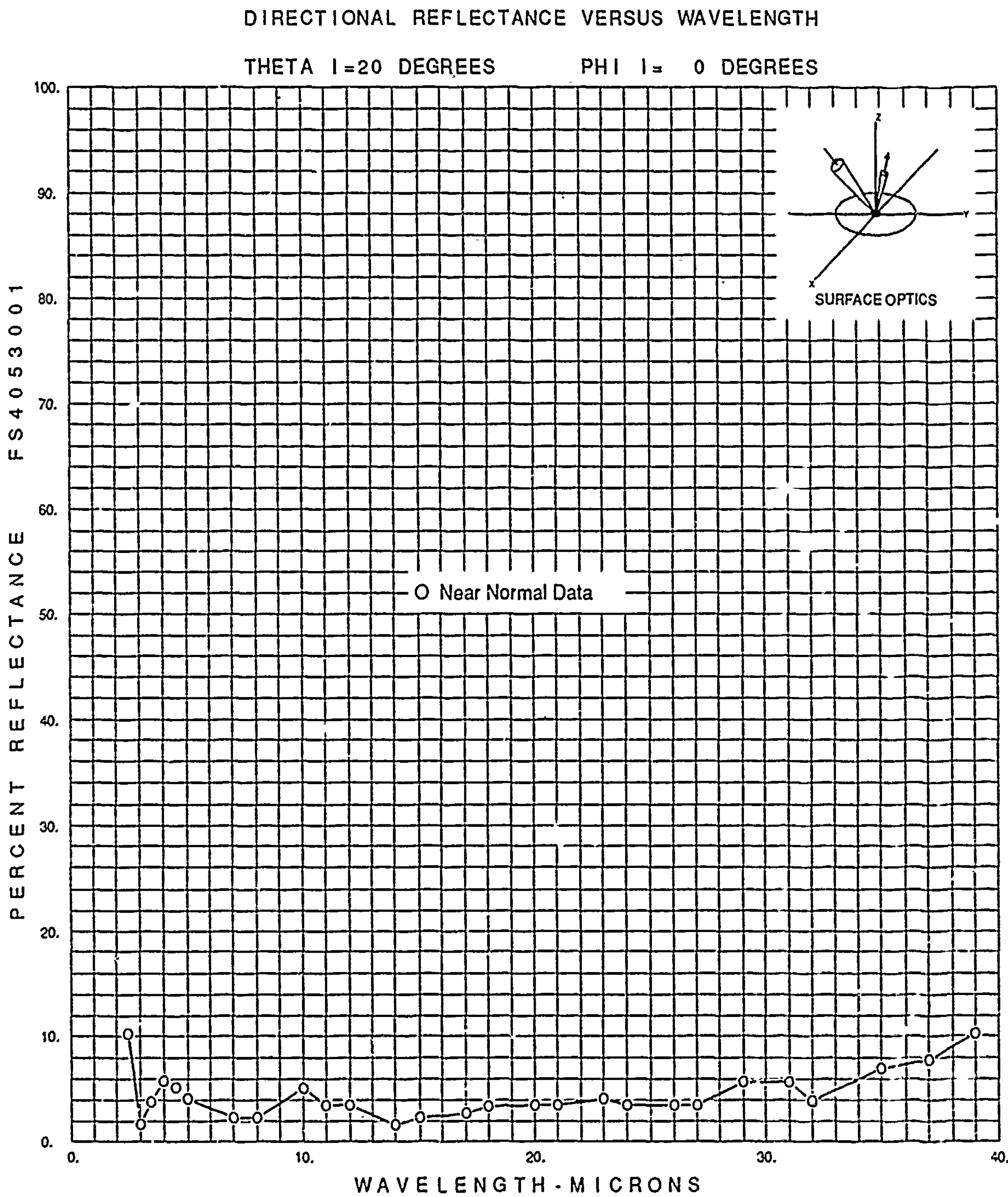

FIGURE Y-2-3. AFSC: BROAD BLADE GRASS
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 2.5 TO 39.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX Y

TABLE Y-2-1. AFSC: BROAD BLADE GRASS
DIRECTIONAL REFLECTANCE VS. WAVELENGTH - ERAS DATA
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

FS40530015001		1	1								
FS40530015101		AFSC: BROAD BLADE GRASS									
FS40530015102		UNCORRECTED FOR INSTRUMENTATION POLARIZATION EFFECTS									
FS40530017001		091186									
FS40530019001	1	001	1	.3	39.	78				20.	0.
FS40530019201	1	.3	4.6	.325	5.0	.35	5.1	.375	5.7	.4	6.8
FS40530019202	1	.425	8.0	.45	8.2	.5	9.9	.525	14.9	.55	16.4
FS40530019203	1	.575	15.3	.6	14.8	.625	14.3	.65	10.3	.675	11.1
FS40530019204	1	.7	23.4	.725	35.8	.75	40.0	.8	43.1	.9	46.2
FS40530019205	1	.925	47.0	.975	46.9	1.	47.7	1.1	48.6	1.125	48.8
FS40530019206	1	1.15	46.9	1.2	46.9	1.225	46.9	1.25	47.4	1.275	45.7
FS40530019207	1	1.3	47.0	1.325	46.0	1.35	43.1	1.375	38.1	1.4	32.2
FS40530019208	1	1.425	26.3	1.45	25.6	1.475	27.3	1.5	30.9	1.575	36.8
FS40530019209	1	1.6	37.5	1.65	38.8	1.7	38.1	1.775	34.5	1.8	34.6
FS40530019210	1	1.825	34.8	1.85	31.7	1.875	21.7	1.9	10.6	1.925	11.3
FS40530019211	1	2.	10.2	2.5	10.2	3.	1.7	3.5	3.8	4.	5.8
FS40530019212	1	4.5	5.2	5.	4.1	7.	2.2	8.	2.3	10.	5.1
FS40530019213	1	11.	3.4	12.	3.4	14.	1.6	15.	2.3	17.	2.7
FS40530019214	1	18.	3.3	20.	3.5	21.	3.5	23.	4.1	24.	3.5
FS40530019215	1	26.	3.5	27.	3.4	29.	5.7	31.	5.6	32.	3.9
FS40530019216	1	35.	7.0	37.	7.7	39.	10.2				

APPENDIX Y

TABLE Y-2-2. AFSC: BROAD BLADE GRASS
DIRECTIONAL EMITTANCE AS A FUNCTION OF TEMPERATURE
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

FS4053001: AFSC: BROAD BLADE GRASS
UNCORRECTED FOR INSTRUMENTATION POLARIZATION EFFECTS

Emittance tabulated as a function of temperature:

Zenith angle (degrees)	Wavelength range (microns)	Temperature (degrees Kelvin) 100	200	300	400	500	600
20	0.300 - 39.000	0.951	0.963	0.966	0.967	0.965	0.963

APPENDIX Y

TABLE Y-2-3. AFSC: BROAD BLADE GRASS SOLAR ABORPTANCE

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FS4053001                          Surface Optics Corp.   20 degrees
AFSC: BROAD BLADE GRASS

The exoatmospheric solar absorptance is 0.751.
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DIRECTIONAL REFLECTANCE VERSUS WAVELENGTH

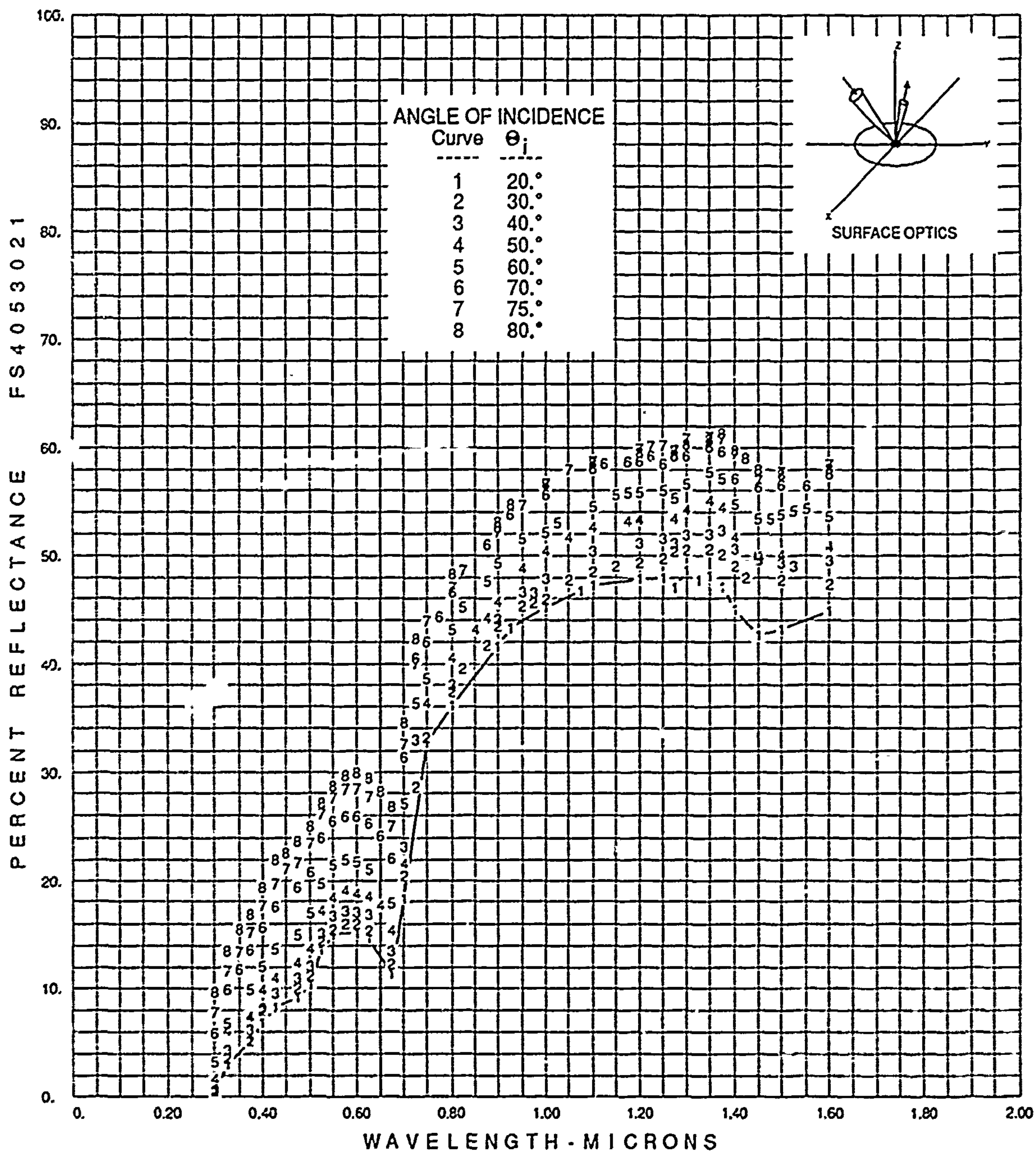

FIGURE Y-2-4. AFSC: BROAD BLADE GRASS
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 2.0 MICROMETERS
DATA CORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX Y

TABLE Y-2-4. AFSC: BROAD BLADE GRASS
DIRECTIONAL REFLECTANCE VS. WAVELENGTH - ERAS DATA
DATA CORRECTED FOR INSTRUMENTATION POLARIZATION

FS40530215001		8	1								
FS40530215101		AFSC: BROAD BLADE GRASS									
FS40530215102		CORRECTED FOR INSTRUMENTATION POLARIZATION EFFECTS									
FS40530217001		081586									
FS40530219001	1	001	1	.3	1.6	31				20.	0.
FS40530219201	1	.3	0.6	.325	3.0	.375	5.2	.4	6.9	.425	8.3
FS40530219202	1	.475	9.2	.5	10.4	.525	13.5	.55	15.1	.6	15.2
FS40530219203	1	.625	14.6	.675	11.3	.7	18.4	.75	32.6	.8	36.1
FS40530219204	1	.9	41.6	.925	43.4	1.	45.2	1.075	46.8	1.1	47.2
FS40530219205	1	1.2	47.9	1.25	48.0	1.275	47.0	1.3	48.6	1.325	47.8
FS40530219206	1	1.35	48.1	1.375	47.0	1.4	45.0	1.45	42.6	1.5	43.3
FS40530219207	1	1.6	44.8								
FS40530219001	2	001	1	.3	1.6	35				30.	0.
FS40530219201	2	.3	0.6	.325	3.6	.375	5.2	.4	7.9	.475	10.0
FS40530219202	2	.5	11.1	.525	14.4	.55	15.5	.575	15.9	.6	16.0
FS40530219203	2	.625	15.4	.675	12.2	.7	20.4	.725	28.7	.75	33.2
FS40530219204	2	.8	37.4	.825	39.5	.875	41.7	.9	43.6	.95	45.3
FS40530219205	2	.975	45.7	1.	45.9	1.05	47.8	1.1	48.5	1.15	49.1
FS40530219206	2	1.2	49.3	1.25	49.7	1.275	50.4	1.3	50.5	1.35	50.6
FS40530219207	2	1.375	50.2	1.4	49.1	1.425	48.0	1.5	47.7	1.6	47.3
FS40530219001	3	001	1	.3	1.6	32				40.	0.
FS40530219201	3	.3	0.7	.325	4.3	.375	6.2	.4	8.2	.425	9.6
FS40530219202	3	.475	11.0	.5	12.1	.525	15.1	.55	16.7	.575	17.2
FS40530219203	3	.6	17.0	.625	16.8	.675	13.4	.7	23.2	.725	32.9
FS40530219204	3	.8	38.0	.9	44.1	.95	46.7	.975	46.6	1.	47.9
FS40530219205	3	1.1	50.4	1.2	51.2	1.25	51.6	1.275	51.1	1.3	51.9
FS40530219206	3	1.35	52.0	1.375	52.4	1.4	50.6	1.45	49.6	1.5	49.3
FS40530219207	3	1.525	49.1	1.6	49.5						
FS40530219001	4	001	1	.3	1.6	34				50.	0.
FS40530219201	4	.3	1.7	.325	6.1	.375	7.4	.4	9.9	.425	11.0
FS40530219202	4	.475	12.3	.5	13.6	.525	17.2	.55	18.5	.575	19.0
FS40530219203	4	.6	18.8	.625	18.6	.65	17.7	.675	15.4	.7	21.6
FS40530219204	4	.75	36.4	.8	40.5	.85	43.2	.875	44.2	.9	45.8
FS40530219205	4	.95	48.8	1.	50.4	1.05	51.7	1.1	52.6	1.175	53.2
FS40530219206	4	1.2	53.3	1.275	53.4	1.3	54.2	1.35	55.1	1.375	54.4
FS40530219207	4	1.4	51.7	1.45	49.9	1.5	50.2	1.6	50.8		
FS40530219001	5	001	1	.3	1.6	39				60.	0.
FS40530219201	5	.3	3.2	.325	6.7	.375	9.9	.4	12.1	.425	13.6
FS40530219202	5	.475	15.0	.5	16.9	.525	19.7	.55	21.4	.575	22.0
FS40530219203	5	.6	21.8	.625	21.1	.675	17.8	.7	27.1	.725	36.3
FS40530219204	5	.75	38.7	.8	43.2	.825	45.2	.875	47.6	.9	49.3
FS40530219205	5	.95	51.5	1.	52.1	1.025	53.0	1.1	54.6	1.15	55.7
FS40530219206	5	1.175	55.9	1.2	55.9	1.25	56.0	1.275	55.3	1.3	56.6
FS40530219207	5	1.35	57.7	1.375	57.1	1.4	54.8	1.45	53.5	1.475	53.5
FS40530219208	5	1.5	53.8	1.525	54.1	1.55	54.3	1.6	53.7		
FS40530219001	6	001	1	.3	1.6	39				70.	0.
FS40530219201	6	.3	5.9	.325	9.9	.35	11.8	.375	13.5	.4	15.6
FS40530219202	6	.425	17.6	.475	19.3	.5	20.8	.525	24.0	.55	25.6

TABLE Y-2-4. (CONTINUED)

FS40530219203	6	.575	25.9	.6	25.9	.625	25.4	.65	24.2	.675	22.1
FS40530219204	6	.7	31.3	.725	40.5	.75	42.0	.775	44.4	.8	46.7
FS40530219205	6	.875	51.0	.9	52.6	.925	53.8	1.	55.7	1.1	58.1
FS40530219206	6	1.125	58.5	1.175	58.7	1.2	58.7	1.225	59.3	1.25	58.5
FS40530219207	6	1.275	59.3	1.3	59.3	1.35	60.1	1.375	59.6	1.4	57.1
FS40530219208	6	1.45	56.3	1.5	56.5	1.55	56.4	1.6	57.5		
FS40530219001	7	001	1	.3	1.6	36				75.	0.
FS40530219201	7	.3	7.7	.325	11.6	.35	13.3	.375	15.2	.4	17.7
FS40530219202	7	.425	19.7	.45	21.1	.475	21.7	.5	23.4	.525	26.1
FS40530219203	7	.55	27.7	.575	28.4	.6	28.4	.625	27.8	.675	25.0
FS40530219204	7	.7	32.5	.725	40.1	.75	43.9	.8	47.0	.825	48.6
FS40530219205	7	.9	52.3	.95	54.7	1.	56.6	1.05	57.9	1.1	58.7
FS40530219206	7	1.2	59.8	1.225	60.1	1.25	60.2	1.275	59.7	1.3	60.8
FS40530219207	7	1.35	61.0	1.375	60.8	1.4	59.4	1.45	57.0	1.5	57.7
FS40530219208	7	1.6	58.4								
FS40530219001	8	001	1	.3	1.6	33				80.	0.
FS40530219201	8	.3	9.7	.325	13.4	.35	15.5	.375	16.8	.4	19.4
FS40530219202	8	.425	22.0	.45	22.5	.475	23.6	.5	25.1	.525	27.1
FS40530219203	8	.55	28.8	.575	29.7	.6	30.0	.625	29.4	.65	28.2
FS40530219204	8	.675	26.8	.7	34.6	.725	42.4	.8	48.3	.9	53.1
FS40530219205	8	.925	54.8	1.	56.6	1.1	58.6	1.2	59.5	1.275	59.7
FS40530219206	8	1.3	60.4	1.35	60.8	1.375	61.3	1.4	59.7	1.425	59.1
FS40530219207	8	1.45	58.0	1.5	57.5	1.6	58.1				

APPENDIX Y

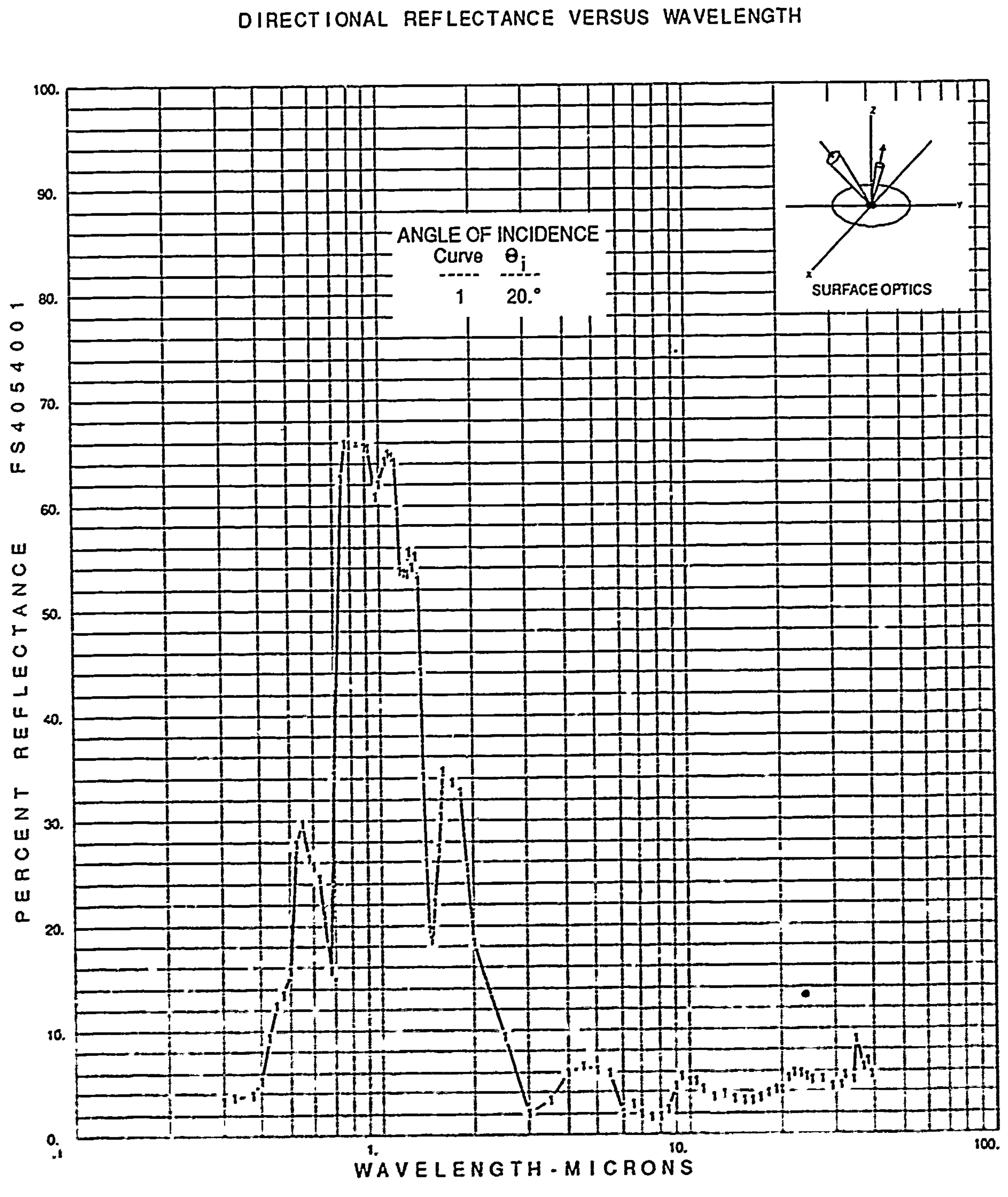

FIGURE Y-3-1. AFSC: FINE BLADE GRASS AND OTHER FLORA
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 39.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX Y

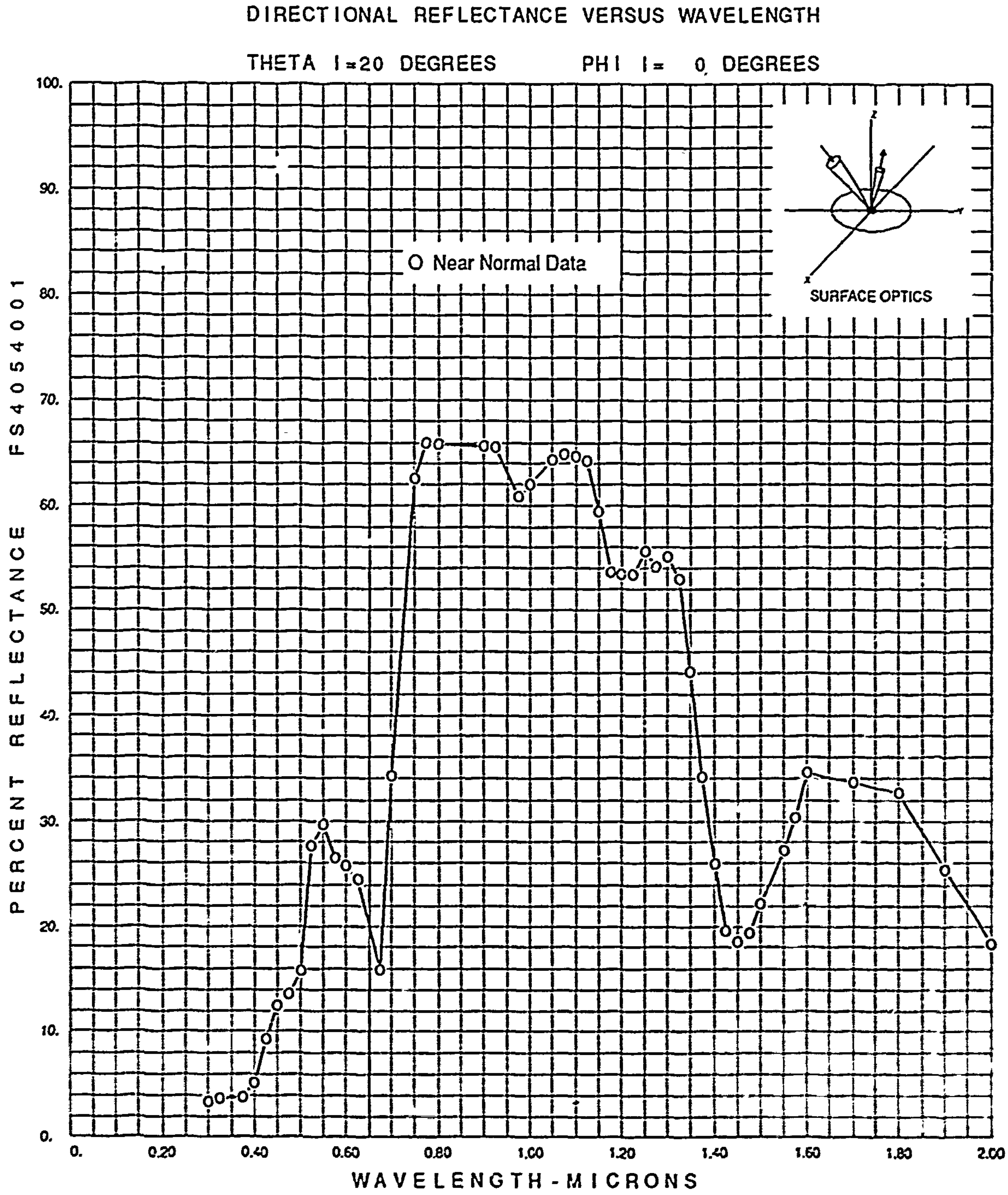

FIGURE Y-3-2. AFSC: FINE BLADE GRASS AND OTHER FLORA
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 2.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

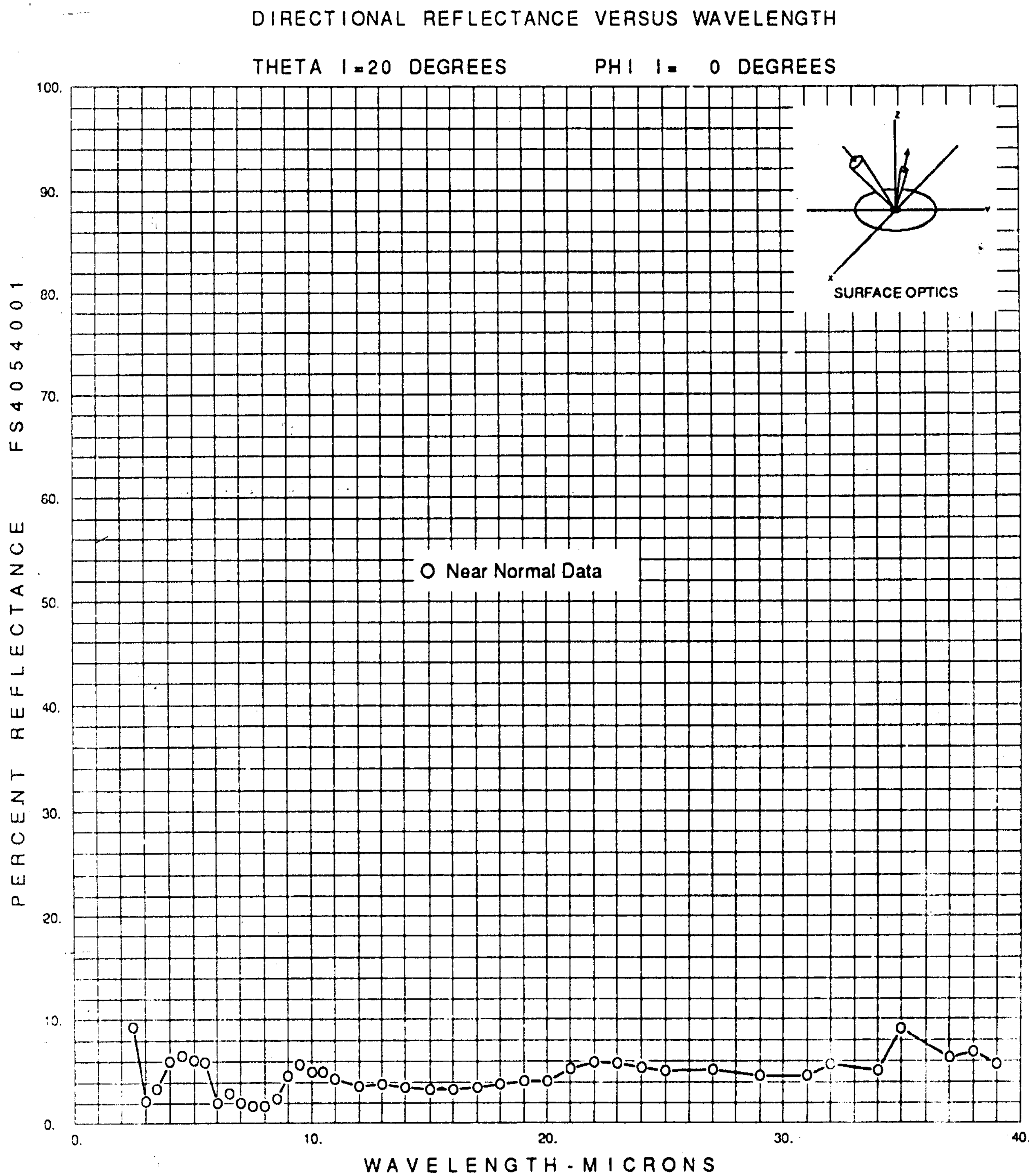

FIGURE Y-3-3. AFSC: FINE BLADE GRASS AND OTHER FLORA
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 2.5 TO 39.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX Y

TABLE Y-3-1. AFSC: FINE BLADE GRASS AND OTHER FLORA
DIRECTIONAL REFLECTANCE VS. WAVELENGTH - ERAS DATA
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

FS40540015001		1	1								
FS40540015101		AFSC: FINE BLADE GRASS AND OTHER FLORA									
FS40540015102		UNCORRECTED FOR INSTRUMENTATION POLARIZATION EFFECTS									
FS40540017001		090186									
FS40540019001	1	001	1	.3	39.	89				20.	0.
FS40540019201	1	.3	3.3	.325	3.7	.375	3.8	.4	5.2	.425	9.3
FS40540019202	1	.45	12.4	.475	13.5	.5	15.7	.525	27.7	.55	29.7
FS40540019203	1	.575	26.5	.6	25.7	.625	24.5	.675	15.8	.7	34.3
FS40540019204	1	.75	62.6	.775	65.9	.8	65.8	.9	65.6	.925	65.5
FS40540019205	1	.975	60.8	1.	62.0	1.05	64.3	1.075	64.9	1.1	64.6
FS40540019206	1	1.125	64.2	1.15	59.4	1.175	53.7	1.2	53.5	1.225	53.4
FS40540019207	1	1.25	55.6	1.275	54.1	1.3	55.1	1.325	52.9	1.35	44.1
FS40540019208	1	1.375	34.2	1.4	25.9	1.425	19.6	1.45	18.6	1.475	19.4
FS40540019209	1	1.5	22.2	1.55	27.3	1.575	30.3	1.6	34.6	1.7	33.6
FS40540019210	1	1.8	32.6	1.9	25.5	2.	18.4	2.5	9.3	3.	2.1
FS40540019211	1	3.5	3.3	4.	6.0	4.5	6.5	5.	6.1	5.5	5.9
FS40540019212	1	6.	2.0	6.5	2.9	7.	2.0	7.5	1.7	8.	1.7
FS40540019213	1	8.5	2.4	9.	4.6	9.5	5.6	10.	5.0	10.5	5.0
FS40540019214	1	11.	4.3	12.	3.6	13.	3.8	14.	3.4	15.	3.2
FS40540019215	1	16.	3.2	17.	3.5	18.	3.8	19.	4.1	20.	4.1
FS40540019216	1	21.	5.3	22.	5.9	23.	5.8	24.	5.4	25.	5.1
FS40540019217	1	27.	5.2	29.	4.5	31.	4.6	32.	5.6	34.	5.1
FS40540019218	1	35.	9.0	37.	6.3	38.	6.9	39.	5.7		

APPENDIX Y

TABLE Y-3-2. AFSC: FINE BLADE GRASS AND OTHER FLORA DIRECTIONAL EMITTANCE AS A FUNCTION OF TEMPERATURE DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

FS4054001: AFSC: FINE BLADE GRASS AND OTHER FLORA
UNCORRECTED FOR INSTRUMENTATION POLARIZATION EFFECTS

Emittance tabulated as a function of temperature:

Zenith angle (degrees)	Wavelength range (microns)	Temperature (degrees Kelvin) 100	200	300	400	500	600
20	0.300 - 39.000	0.947	0.955	0.959	0.961	0.960	0.958

APPENDIX Y

TABLE Y-3-3. AFSC: FINE BLADE GRASS AND OTHER FLORA SOLAR ABORPTANCE

```
FS4054001                                 Surface Optics Corp.   20 degrees
AFSC: FINE BLADE GRASS AND OTHER FLORA

The exoatmospheric solar absorptance is 0.667.
```

DIRECTIONAL REFLECTANCE VERSUS WAVELENGTH

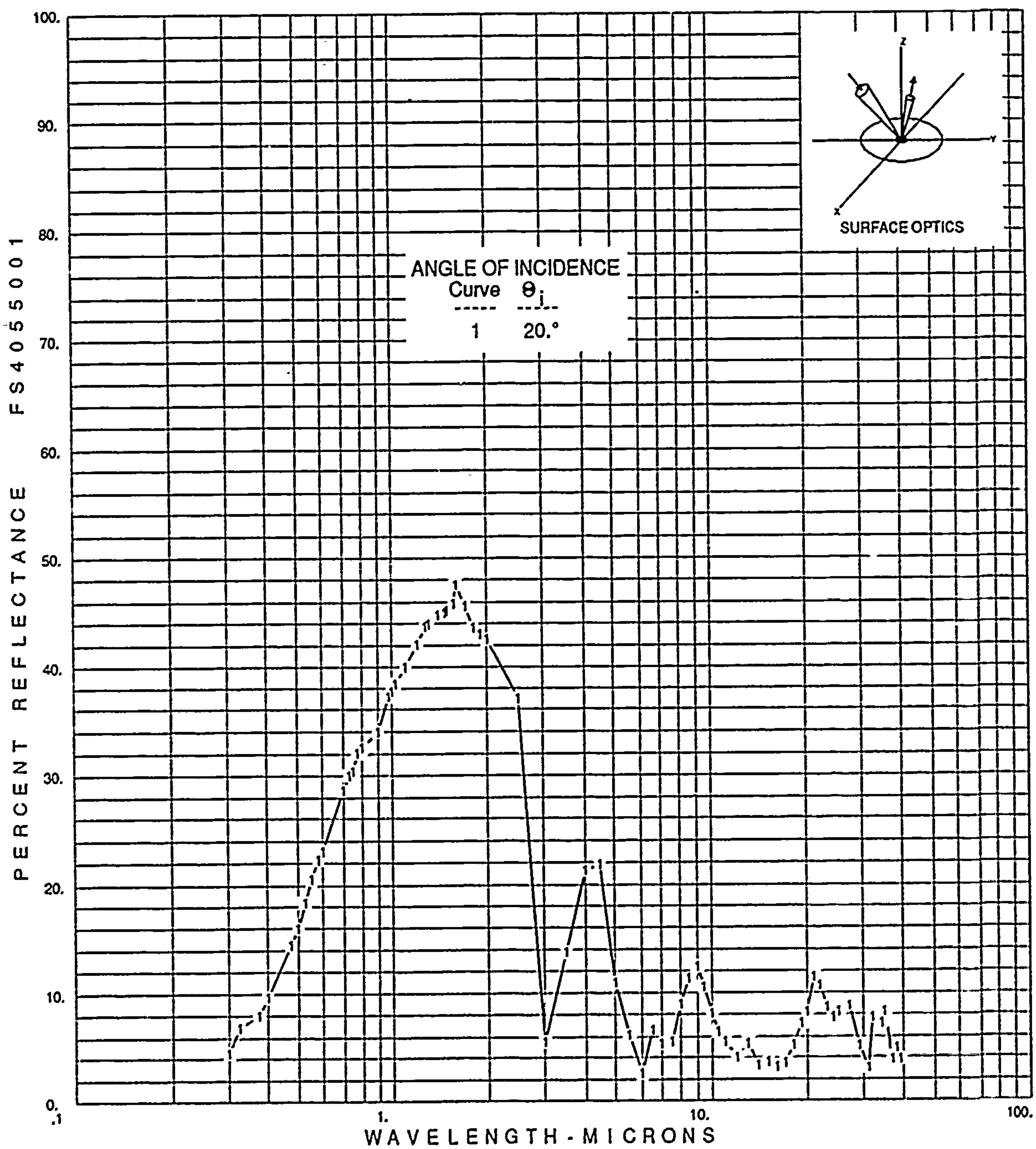

FIGURE Y-4-1. AFSC: EARTH (DRY) TYPICAL OF AREA
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 39.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

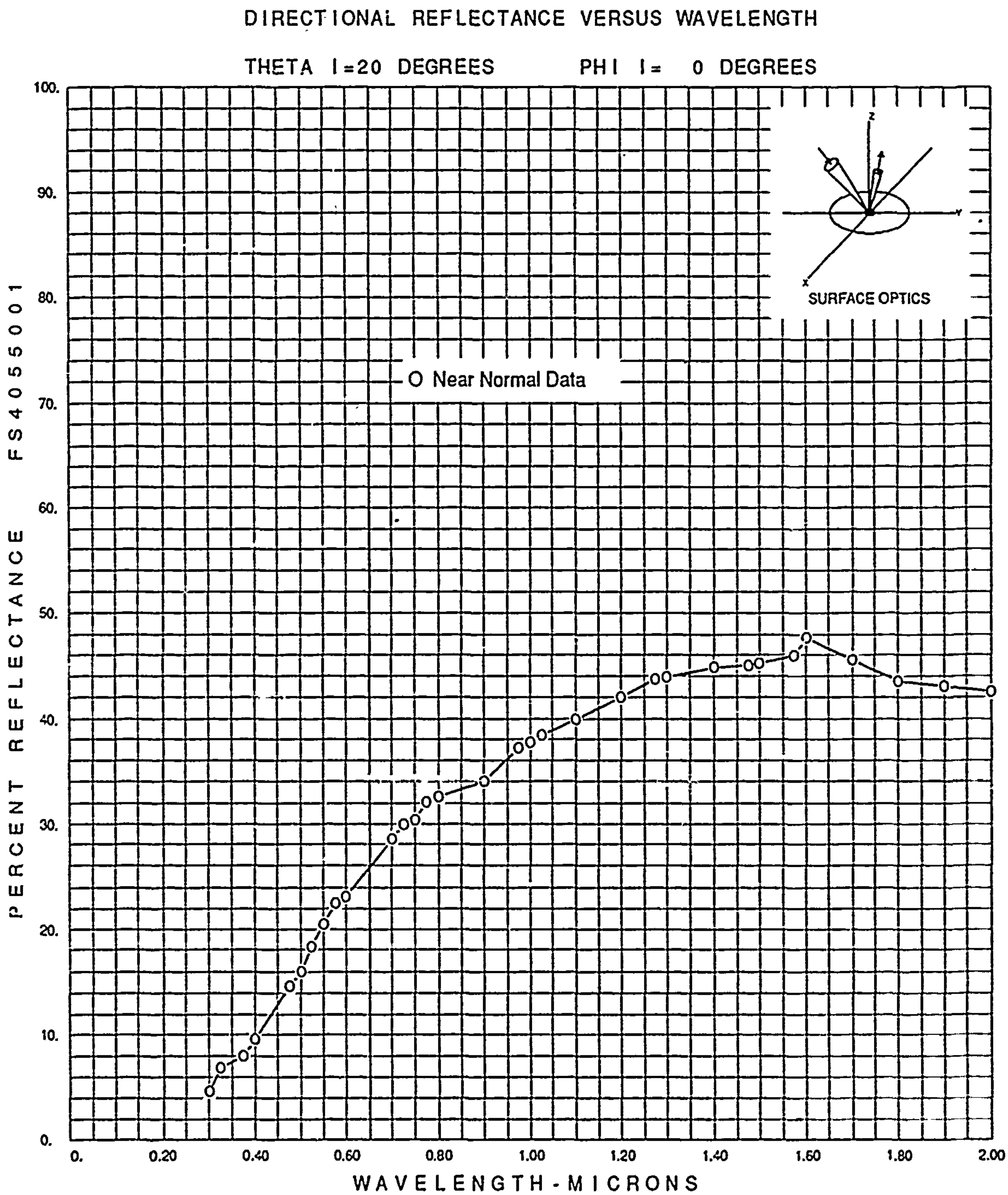

FIGURE Y-4-2. AFSC: EARTH (DRY) TYPICAL OF AREA
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 2.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

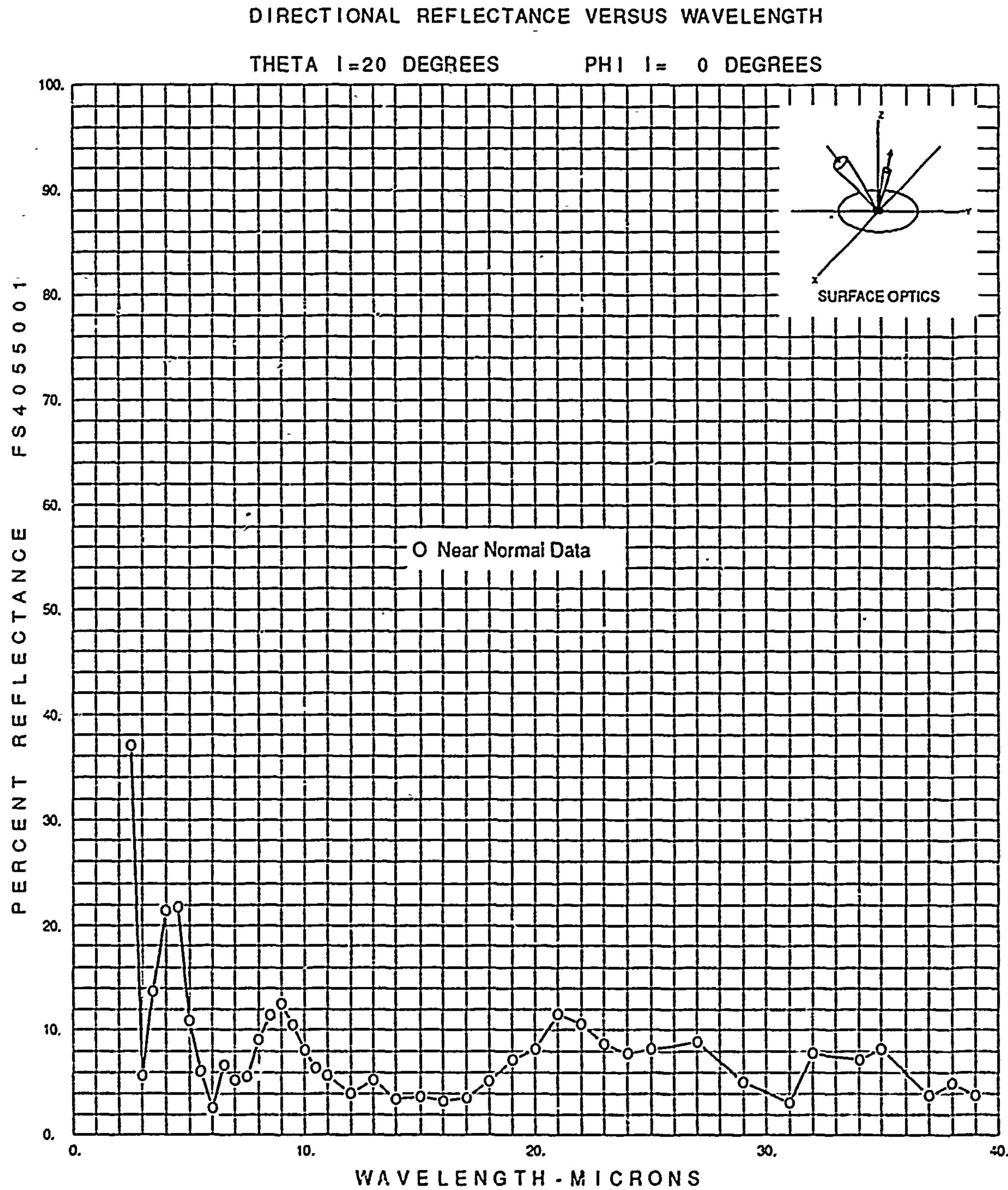

FIGURE Y-4-3. AFSC: EARTH (DRY) TYPICAL OF AREA
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 2.5 TO 39.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX Y

TABLE Y-4-1. AFSC: EARTH (DRY) TYPICAL OF AREA
DIRECTIONAL REFLECTANCE VS. WAVELENGTH - ERAS DATA
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

FS40550015001		1	1								
FS40550015101		AFSC: EARTH (DRY) TYPICAL OF AREA									
FS40550015102		UNCORRECTED FOR INSTRUMENTATION POLARIZATION EFFECTS									
FS40550017001		082886									
FS40550019001	1	001	1	.3	39.	73				20.	0.
FS40550019201	1	.3	4.6	.325	6.9	.375	8.0	.4	9.6	.475	14.5
FS40550019202	1	.5	16.0	.525	18.4	.55	20.5	.575	22.4	.6	23.1
FS40550019203	1	.7	28.6	.725	30.0	.75	30.3	.775	32.1	.8	32.5
FS40550019204	1	.9	34.0	.975	37.2	1.	37.8	1.025	38.4	1.1	40.0
FS40550019205	1	1.2	42.1	1.275	43.7	1.3	43.9	1.4	44.8	1.475	45.0
FS40550019206	1	1.5	45.2	1.575	45.9	1.6	47.6	1.7	45.6	1.8	43.6
FS40550019207	1	1.9	43.0	2.	42.5	2.5	37.0	3.	5.6	3.5	13.7
FS40550019208	1	4.	21.3	4.5	21.8	5.	10.9	5.5	6.1	6.	2.6
FS40550019209	1	6.5	6.6	7.	5.3	7.5	5.5	8.	9.0	8.5	11.4
FS40550019210	1	9.	12.4	9.5	10.5	10.	8.1	10.5	6.4	11.	5.6
FS40550019211	1	12.	4.0	13.	5.3	14.	3.4	15.	3.7	16.	3.2
FS40550019212	1	17.	3.6	18.	5.2	19.	7.2	20.	8.2	21.	11.5
FS40550019213	1	22.	10.6	23.	8.7	24.	7.7	25.	8.2	27.	8.8
FS40550019214	1	29.	5.1	31.	3.1	32.	7.7	34.	7.2	35.	8.2
FS40550019215	1	37.	3.8	38.	4.9	39.	3.8				

APPENDIX Y

TABLE Y-4-2. AFSC: EARTH (DRY) TYPICAL OF AREA
DIRECTIONAL EMITTANCE AS A FUNCTION OF TEMPERATURE
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

FS4055001: AFSC: EARTH (DRY) TYPICAL OF AREA
UNCORRECTED FOR INSTRUMENTATION POLARIZATION EFFECTS

Emittance tabulated as a function of temperature:

Zenith angle (degrees)	Wavelength range (microns)	Temperature (degrees Kelvin) 100	200	300	400	500	600
20	0.300 - 39.000	0.932	0.936	0.933	0.926	0.915	0.902

TABLE Y-4-3. AFSC: EARTH (DRY) TYPICAL OF AREA SOLAR ABORPTANCE

FS4055001 Surface Optics Corp. 20 degrees
AFSC: EARTH (DRY) TYPICAL OF AREA

The exoatmospheric solar absorptance is 0.726.

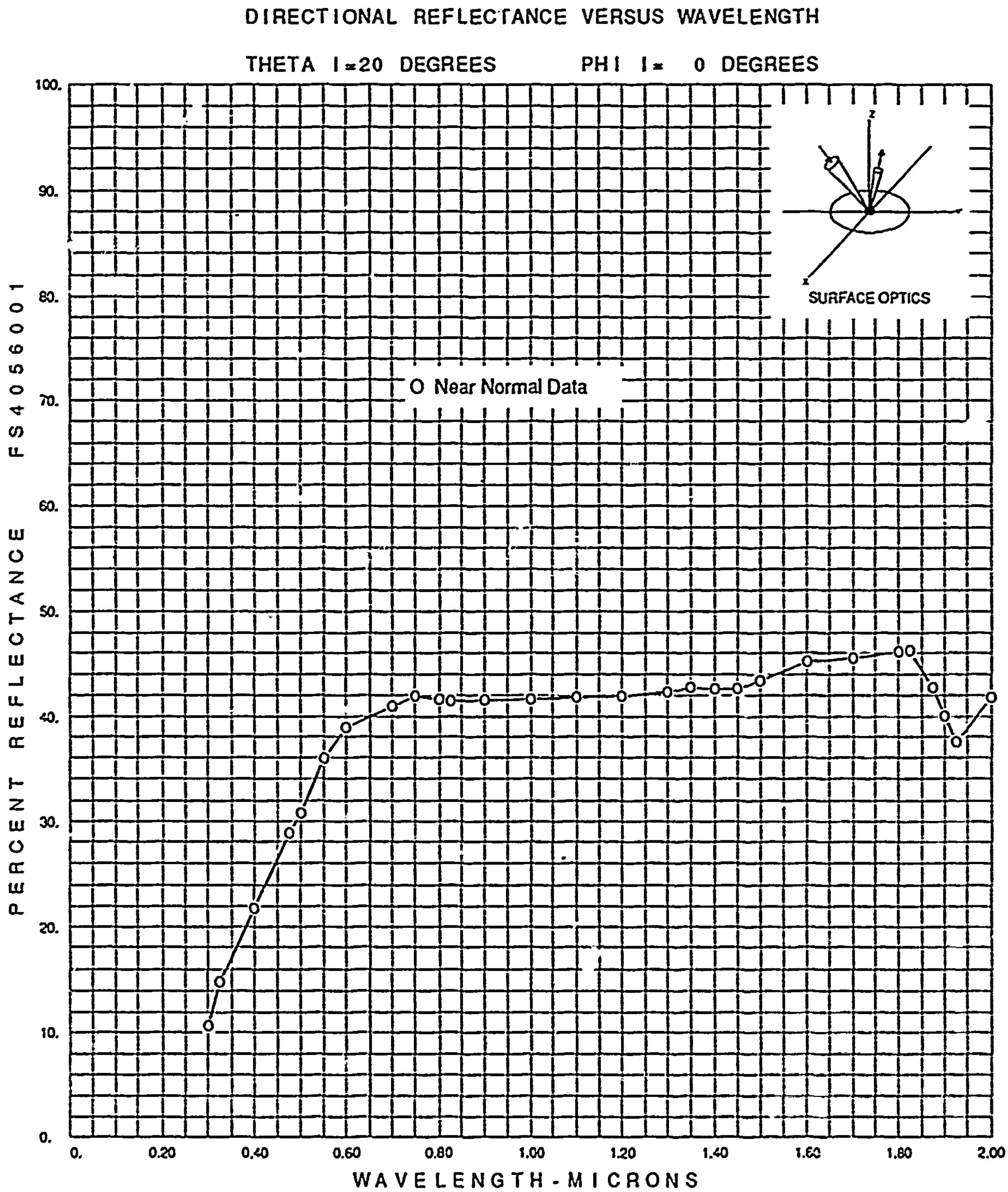

FIGURE Y-5-1. AFSC: FINISHED CEMENT
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 2.0 MICROMETERS
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX Y

TABLE Y-5-1. AFSC: FINISHED CEMENT
DIRECTIONAL REFLECTANCE VS. WAVELENGTH - ERAS DATA
DATA UNCORRECTED FOR INSTRUMENTATION POLARIZATION

```
FS40560015001          1      1
FS40560015101       AFSC: FINISHED CEMENT
FS40560015102       UNCORRECTED FOR INSTRUMENTATION POLARIZATION EFFECTS
FS40560017001       090986
FS40560019001    1         001  1     .3     2.  28                          20.      0.
FS40560019201    1      .3  10.7  .325  14.7     .4  21.8  .475  28.9     .5  30.8
FS40560019202    1     .55  35.9    .6  39.0     .7  40.9   .75  41.9     .8  41.6
FS40560019203    1    .825  41.4    .9  41.5     1.  41.6   1.1  41.8    1.2  41.9
FS40560019204    1     1.3  42.4  1.35  42.7    1.4  42.6  1.45  42.6    1.5  43.5
FS40560019205    1     1.6  45.2   1.7  45.6    1.8  46.1 1.825  46.2  1.875  42.7
FS40560019206    1     1.9  40.1 1.925  37.6     2.  41.8
```

APPENDIX Y

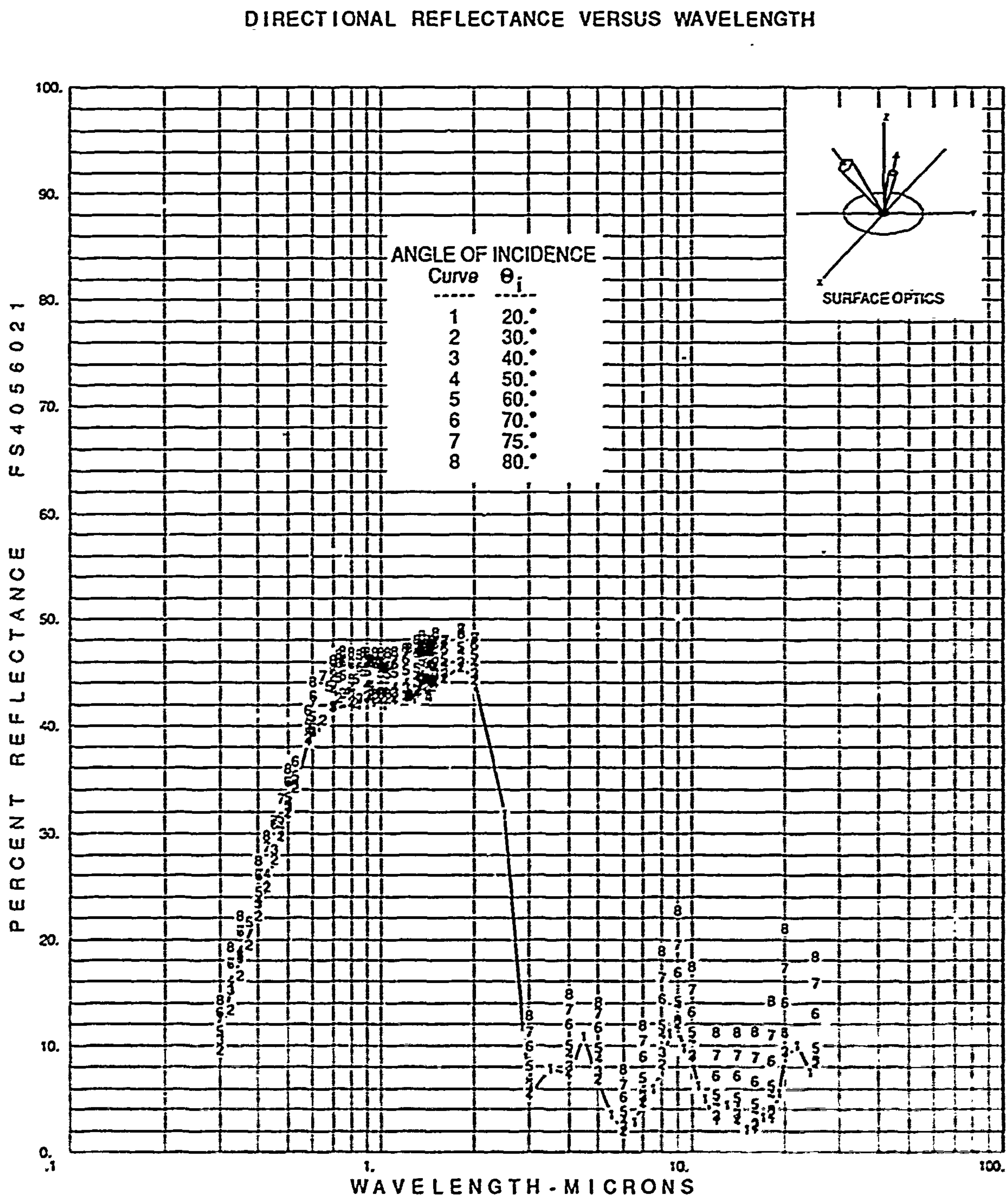

FIGURE Y-5-2. AFSC: FINISHED CEMENT
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 25.0 MICROMETERS
DATA CORRECTED FOR INSTRUMENTATION POLARIZATION

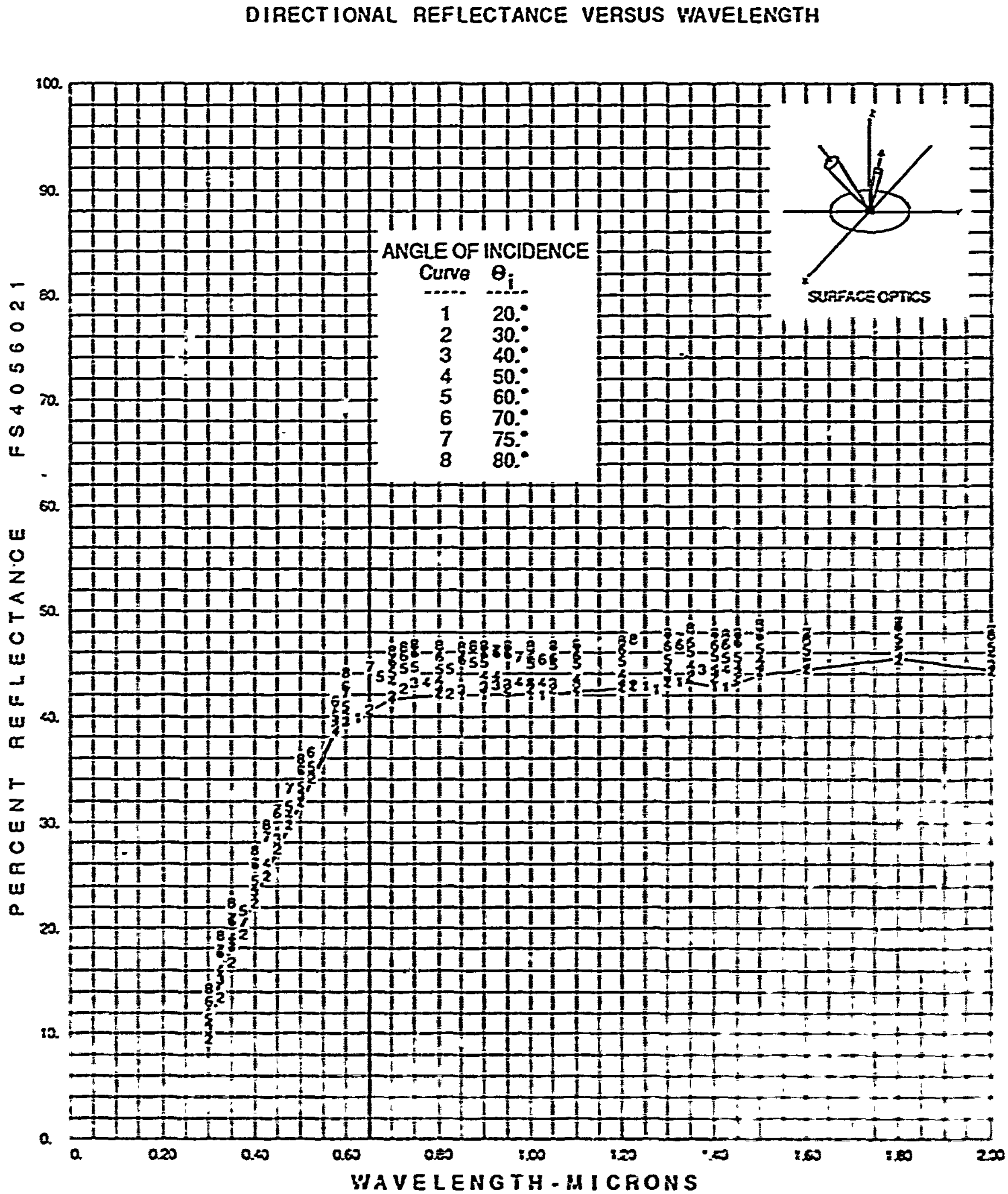

FIGURE Y-5-3. AFSC: FINISHED CEMENT
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 0.3 TO 2.0 MICROMETERS
DATA CORRECTED FOR INSTRUMENTATION POLARIZATION

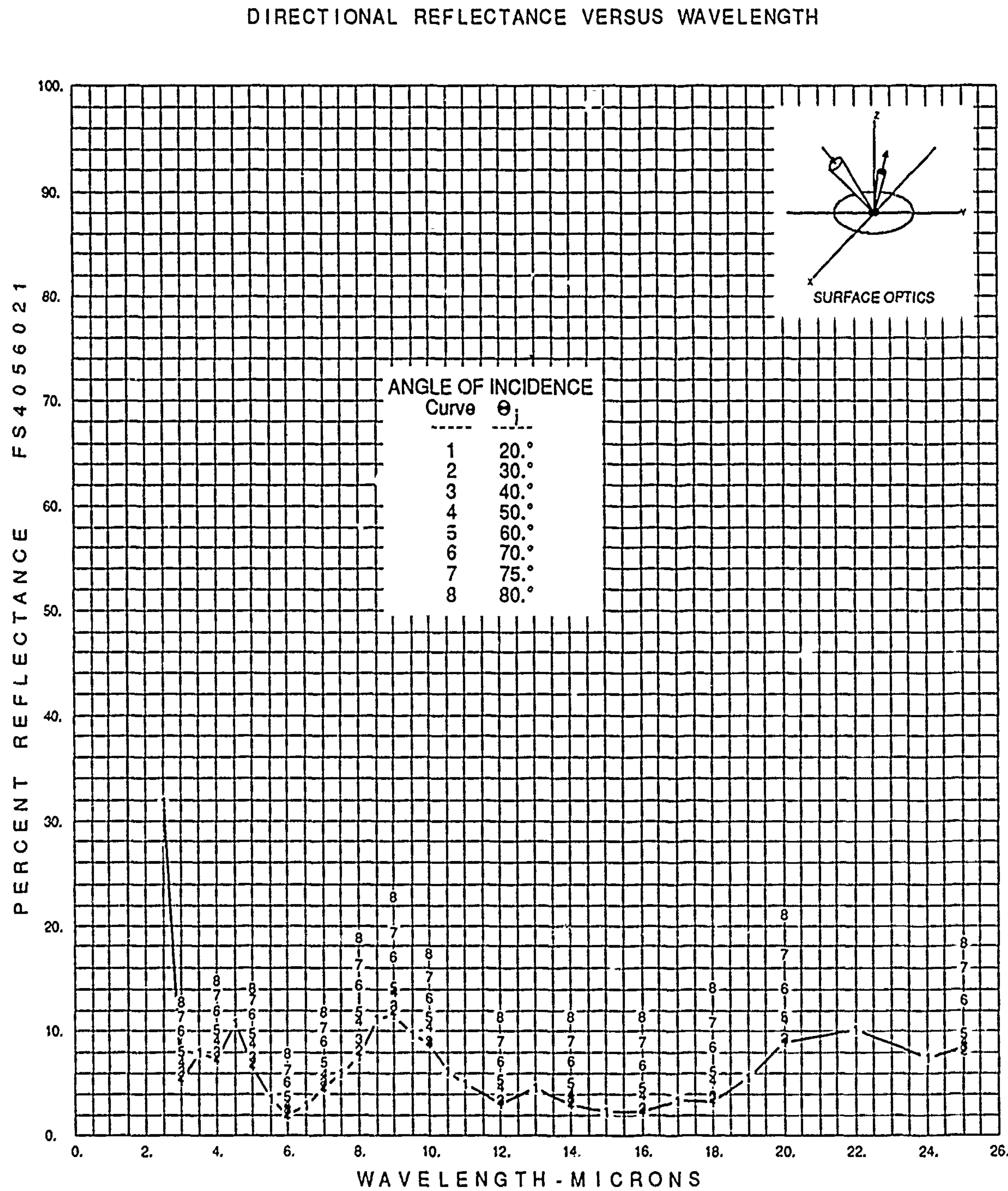

FIGURE Y-5-4. AFSC: FINISHED CEMENT
DIRECTIONAL REFLECTANCE VS. WAVELENGTH
BANDWIDTH 2.5 TO 25.0 MICROMETERS
DATA CORRECTED FOR INSTRUMENTATION POLARIZATION

APPENDIX Y

TABLE Y-5-2. AFSC: FINISHED CEMENT
DIRECTIONAL REFLECTANCE VS. WAVELENGTH - ERAS DATA
DATA CORRECTED FOR INSTRUMENTATION POLARIZATION

FS40560215001		8	1								
FS40560215101		AFSC: FINISHED CEMENT									
FS40560215102		CORRECTED FOR INSTRUMENTATION POLARIZATION EFFECTS									
FS40560217001		091086									
FS40560219001	1	001	1	.3	25.	59				20.	0.
FS40560219201	1	.3	9.7	.325	15.5	.35	18.2	.4	22.8	.425	25.2
FS40560219202	1	.475	29.7	.5	31.7	.575	38.5	.6	39.5	.625	39.9
FS40560219203	1	.7	41.6	.8	41.9	.85	42.0	.9	42.0	1.	42.0
FS40560219204	1	1.025	42.0	1.1	42.4	1.2	42.6	1.225	42.7	1.25	42.8
FS40560219205	1	1.275	42.5	1.3	43.1	1.325	43.4	1.4	42.8	1.425	42.7
FS40560219206	1	1.5	43.9	1.6	44.5	1.8	45.6	2.	44.3	2.5	31.7
FS40560219207	1	3.	5.3	3.5	7.9	4.	7.3	4.5	10.8	5.	6.6
FS40560219208	1	5.5	3.6	6.	2.0	6.5	2.9	7.	4.6	7.5	6.0
FS40560219209	1	8.	7.6	8.5	11.1	9.	11.6	9.5	9.7	10.	8.8
FS40560219210	1	10.5	6.2	11.	5.0	12.	3.1	13.	4.5	14.	3.0
FS40560219211	1	15.	2.2	16.	2.3	17.	3.3	18.	3.2	19.	5.5
FS40560219212	1	20.	8.9	22.	10.1	24.	7.5	25.	8.5		
FS40560219001	2	001	1	.3	25.	46				30.	0.
FS40560219201	2	.3	9.5	.325	13.4	.35	16.7	.375	19.4	.4	22.3
FS40560219202	2	.425	24.9	.45	27.5	.475	29.8	.5	32.0	.525	34.2
FS40560219203	2	.575	38.9	.6	39.5	.65	40.6	.7	41.9	.725	42.6
FS40560219204	2	.8	42.3	.825	42.2	.9	42.7	.95	42.6	1.	42.6
FS40560219205	2	1.05	42.6	1.1	42.7	1.2	42.8	1.225	42.9	1.3	43.4
FS40560219206	2	1.35	43.8	1.4	43.7	1.45	43.7	1.5	44.3	1.6	44.6
FS40560219207	2	1.8	45.5	2.	44.3	3.	5.7	4.	7.6	5.	7.0
FS40560219208	2	6.	2.1	7.	4.8	8.	8.2	9.	12.1	10.	9.1
FS40560219209	2	12.	3.5	14.	3.2	16.	2.6	18.	3.7	20.	9.4
FS40560219210	2	25.	8.3								
FS40560219001	3	001	1	.3	25.	43				40.	0.
FS40560219201	3	.3	10.5	.325	15.2	.35	18.3	.4	23.4	.45	28.5
FS40560219202	3	.5	32.5	.525	34.5	.575	38.9	.6	39.5	.7	41.9
FS40560219203	3	.75	43.1	.8	42.8	.85	42.5	.9	42.8	.925	42.9
FS40560219204	3	.95	43.0	1.	43.1	1.05	43.1	1.1	43.2	1.2	43.5
FS40560219205	3	1.3	44.1	1.35	44.4	1.375	44.5	1.4	44.4	1.45	44.2
FS40560219206	3	1.5	44.9	1.6	44.9	1.8	46.0	2.	44.9	3.	6.2
FS40560219207	3	4.	8.1	5.	7.6	6.	2.5	7.	5.2	8.	9.3
FS40560219208	3	9.	12.4	10.	9.1	12.	3.5	14.	3.6	16.	2.7
FS40560219209	3	18.	3.9	20.	9.4	25.	8.6				
FS40560219001	4	001	1	.3	25.	42				50.	0.
FS40560219201	4	.3	11.0	.325	16.1	.35	19.0	.4	23.7	.425	26.1
FS40560219202	4	.475	30.7	.5	32.8	.575	39.6	.6	40.4	.7	43.4
FS40560219203	4	.775	43.3	.8	43.5	.9	43.8	.925	43.8	.975	43.3
FS40560219204	4	1.	43.3	1.025	43.3	1.1	43.6	1.2	44.0	1.3	44.6
FS40560219205	4	1.35	44.8	1.4	44.6	1.425	44.5	1.45	44.7	1.5	45.4
FS40560219206	4	1.6	45.7	1.8	46.9	2.	45.9	3.	7.1	4.	9.2
FS40560219207	4	5.	8.8	6.	3.0	7.	6.0	8.	11.0	9.	13.8
FS40560219208	4	10.	10.5	12.	4.7	14.	4.1	16.	3.9	18.	5.4
FS40560219209	4	20.	11.1	25.	9.1						

TABLE Y-5-2. (CONTINUED)

FS40560219001	5	001	1	.3	25.	44				60.	0.
FS40560219201	5	.3	11.4	.35	18.6	.375	21.6	.4	24.5	.475	31.4
FS40560219202	5	.5	33.4	.525	35.3	.575	40.1	.6	40.9	.675	43.7
FS40560219203	5	.7	44.1	.725	44.6	.75	44.7	.8	44.5	.825	44.5
FS40560219204	5	.875	45.1	.9	45.1	1.	45.0	1.05	44.9	1.1	45.0
FS40560219205	5	1.2	45.2	1.3	45.4	1.35	46.1	1.4	45.8	1.425	45.6
FS40560219206	5	1.45	45.7	1.5	46.4	1.6	46.3	1.8	47.4	2.	46.7
FS40560219207	5	3.	8.1	4.	10.1	5.	9.8	6.	3.8	7.	7.1
FS40560219208	5	8.	11.9	9.	14.2	10.	11.3	12.	5.4	14.	5.1
FS40560219209	5	16.	4.6	18.	6.2	20.	11.3	25.	9.8		
FS40560219001	6	001	1	.3	25.	46				70.	0.
FS40560219201	6	.3	13.1	.325	17.7	.35	20.7	.4	26.0	.45	30.9
FS40560219202	6	.5	34.8	.525	36.7	.575	41.4	.6	42.8	.7	45.2
FS40560219203	6	.725	45.8	.75	46.0	.8	45.7	.85	45.5	.9	45.9
FS40560219204	6	.925	46.0	.95	45.9	1.	45.6	1.025	45.5	1.05	45.6
FS40560219205	6	1.1	45.8	1.2	46.3	1.3	46.8	1.325	46.9	1.35	47.0
FS40560219206	6	1.4	46.9	1.425	46.9	1.45	47.1	1.5	47.8	1.6	47.3
FS40560219207	6	1.8	48.6	2.	47.7	3.	10.0	4.	12.0	5.	11.7
FS40560219208	6	6.	5.2	7.	9.0	8.	14.4	9.	17.0	10.	13.2
FS40560219209	6	12.	7.2	14.	7.2	16.	6.7	18.	8.6	20.	14.1
FS40560219210	6	25.	13.0								
FS40560219001	7	001	1	.3	25.	47				75.	0.
FS40560219201	7	.3	12.6	.325	17.8	.35	20.9	.4	26.1	.425	28.7
FS40560219202	7	.45	31.2	.475	33.2	.5	34.8	.575	41.1	.6	4[illegible].3
FS40560219203	7	.65	44.7	.7	45.4	.75	46.1	.8	45.9	.85	45.7
FS40560219204	7	.9	46.0	.925	46.2	.95	46.0	.975	45.7	1.	45.8
FS40560219205	7	1.05	46.0	1.1	46.2	1.2	46.8	1.3	47.3	1.325	47.4
FS40560219206	7	1.35	47.5	1.4	47.3	1.425	47.2	1.45	47.3	1.5	47.9
FS40560219207	7	1.6	48.0	1.8	49.1	2.	48.2	3.	11.3	4.	13.4
FS40560219208	7	5.	13.0	6.	6.3	7.	10.4	8.	16.3	9.	19.4
FS40560219209	7	10.	15.2	12.	9.1	14.	9.1	16.	8.9	18.	10.9
FS40560219210	7	20.	17.3	25.	15.9						
FS40560219001	8	001	1	.3	25.	43				80.	0.
FS40560219201	8	.3	14.3	.325	19.2	.35	22.3	.4	27.4	.425	29.8
FS40560219202	8	.5	35.9	.6	44.1	.7	46.2	.725	46.7	.75	46.9
FS40560219203	8	.8	46.8	.85	46.7	.875	46.8	.9	46.8	.95	46.8
FS40560219204	8	1.	46.8	1.05	46.8	1.1	46.9	1.2	47.2	1.225	47.3
FS40560219205	8	1.3	48.0	1.35	48.4	1.4	48.0	1.425	47.8	1.45	48.0
FS40560219206	8	1.5	48.8	1.6	47.9	1.8	49.0	2.	48.2	3.	12.8
FS40560219207	8	4.	14.8	5.	14.1	6.	7.8	7.	11.9	8.	18.9
FS40560219208	8	9.	22.7	10.	17.4	12.	11.3	14.	11.3	16.	11.4
FS40560219209	8	18.	14.2	20.	21.1	25.	18.4				

APPENDIX Y

TABLE Y-5-3. AFSC: FINISHED CEMENT
DIRECTIONAL AND HEMISPHERICAL EMITTANCE
AS A FUNCTION OF INCIDENT ANGLE AND TEMPERATURE
DATA CORRECTED FOR INSTRUMENTATION POLARIZATION

FS4056021: AFSC: FINISHED CEMENT
CORRECTED FOR INSTRUMENTATION POLARIZATION EFFECTS

Emittance tabulated as a function of zenith angle and temperature:

Zenith angle (degrees)	Wavelength range (microns)	Temperature (degrees Kelvin) 100	200	300	400	500	600
20	0.300 - 25.000	0.930	0.943	0.942	0.941	0.938	0.932
30	0.300 - 25.000	0.929	0.941	0.939	0.938	0.938	0.935
40	0.300 - 25.000	0.928	0.939	0.937	0.935	0.934	0.931
50	0.300 - 25.000	0.916	0.927	0.925	0.923	0.923	0.920
60	0.300 - 25.000	0.911	0.921	0.918	0.916	0.914	0.911
70	0.300 - 25.000	0.883	0.897	0.896	0.894	0.894	0.892
75	0.300 - 25.000	0.855	0.873	0.874	0.875	0.876	0.875
80	0.300 - 25.000	0.825	0.846	0.849	0.853	0.856	0.856
Hemispherical emittance:		0.900	0.913	0.911	0.910	0.909	0.906

APPENDIX Y

TABLE Y-5-4. AFSC: FINISHED CEMENT
SOLAR ABSORBPTANCE AS A FUNCTION OF INCIDENT ANGLE
DATA CORRECTED FOR INSTRUMENTATION POLARIZATION

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FS4056021                         Surface Optics Corp.
AFSC: FINISHED CEMENT

20 degrees: The exoatmospheric solar absorptance is 0.641.
30 degrees: The exoatmospheric solar absorptance is 0.641.
40 degrees: The exoatmospheric solar absorptance is 0.636.
50 degrees: The exoatmospheric solar absorptance is 0.629.
60 degrees: The exoatmospheric solar absorptance is 0.621.
70 degrees: The exoatmospheric solar absorptance is 0.608.
75 degrees: The exoatmospheric solar absorptance is 0.605.
80 degrees: The exoatmospheric solar absorptance is 0.597.
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